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THE WESTINGHOUSE BRAKE EXHIBIT.

The complete recognition of the Westinghouse Automatic Brake, as providing the best means at present available for stopping and controlling trains, and its almost universal adoption on the principal lines of railway in the United States, are gradually having a practical influence upon Continental railway management, which must sooner or later end in the dissipation of those prejudices which have until now been the chief and indeed the only important obstacles to its wide introduction in Europe. The important exhibit of the Westinghouse Air Brake Company at the Centennial Exhibition has contributed largely to convincing the small but important body of foreign visitors—both English and Continental—of the efficiency of the arrangement, and of showing conclusively the truth of all that we have advanced in these pages in favor of the brake. It should be mentioned also that these same visitors had ample opportunity of testing the efficiency of the brake in daily working in the United States, where it is applied on about 200 railroads, over 3,000 locomotives, and 10,000 cars being fitted with it.

The Westinghouse Air Brake Company's exhibit at Philadelphia comprised:—

1. The Westinghouse automatic air brake equipment for a train consisting of a locomotive, tender, and nine cars.

2. Serial compressing apparatus for elastic fluids, for producing high pressure with economy.

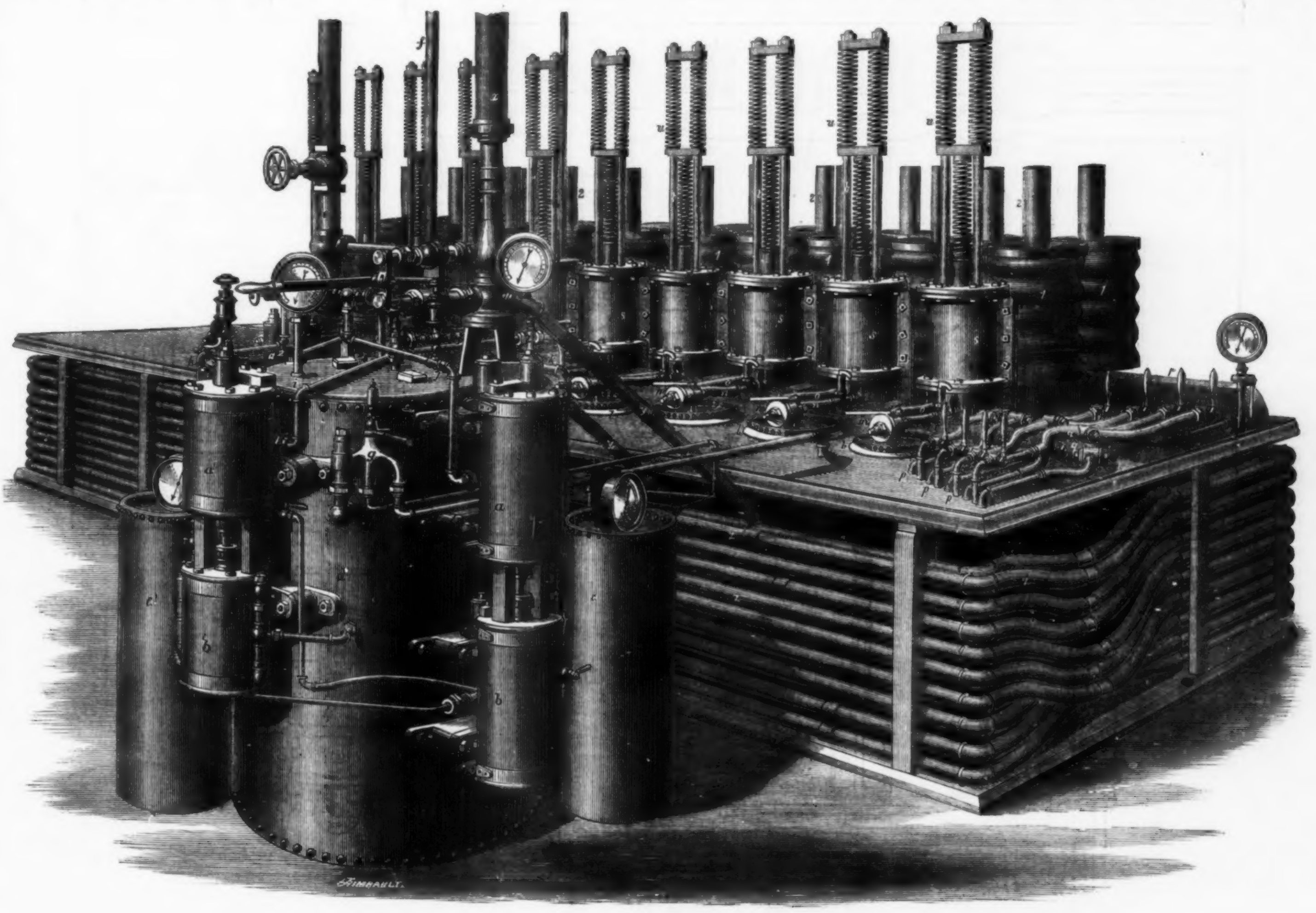
3. The vacuum brake equipment (Westinghouse and Smith's patent) for a locomotive, tender, and nine cars.

4. Pneumatic signalling apparatus in connection with the automatic brake, for giving signals from a train to the locomotive driver.

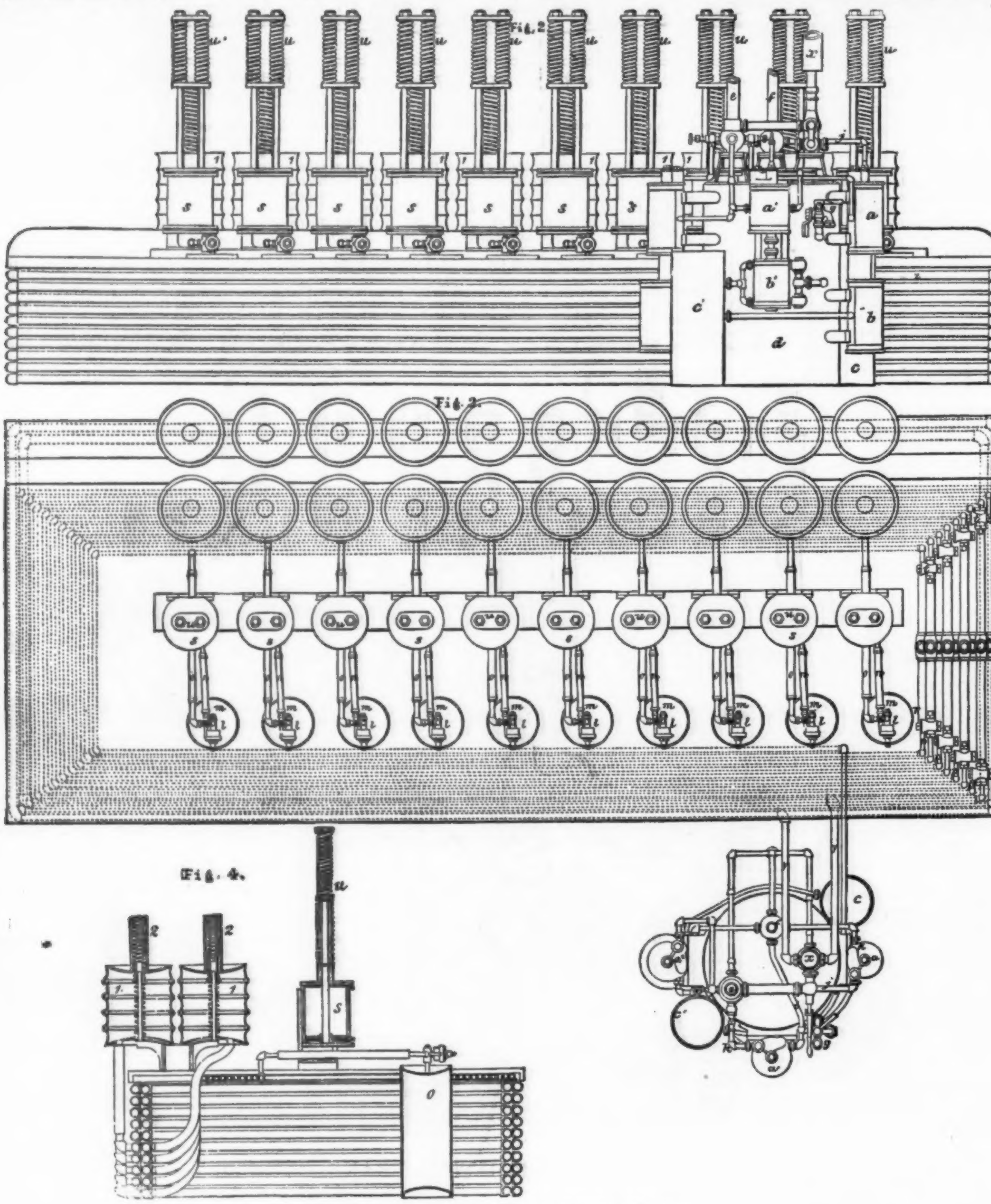
It was obvious that it would be impossible to display the brake apparatus as it would be fitted up in practice, as so doing would involve the introduction of a series of cars, or car frames mounted on their trucks, and carrying the brake apparatus in a position difficult of inspection; moreover, the space occupied would have been more than was available in the building. Mr. Westinghouse accordingly arranged the exhibit as shown in the perspective view above. It consists of a rectangular table, beneath which are placed the coils of pipe representing the length required for fitting up nine carriages, both for the automatic and vacuum systems. The air reservoirs are also placed under the table, and on the tops of each the connections leading to the brake cylinders. These latter are ranged vertically in a row as shown, and above them are placed a double series of springs against which pistons of the brake cylinders act when the air pressure is applied. In front of these cylinders are two rows of the rubber bags which form the distinguishing feature of the vacuum brake, and within them are placed a series of springs which are compressed by the action of the exhaust. In front of the table are placed the compressing and exhausting apparatus. The former consists of a large compressed air reservoir, and placed around it are three pumps which communicate one with another, and compress the air by stages till the final reservoir pressure is attained. It is needless to point out that this arrangement does not represent that of actual practice, in which only one pump is employed. Over the compressing apparatus are placed the exhaust nozzle and pipes for working the vacuum brake, and in which an important improvement has been made by Mr. Westinghouse.

1. *The Westinghouse Automatic Air Brake.*—The brake apparatus exhibited represents its application upon a train of the size above mentioned in all respects, excepting the arrangement of the various parts, the absence of brake gear, and the introduction of springs to absorb the power exerted by the compressed air upon the pistons in the brake cylinders. The piping is ranged in parallel lines beneath the table, as shown in the plan, Fig. 3, and section, Fig. 4, and the flexible couplings corresponding to the unions between the carriages are all brought together and grouped on the top, and at the right-hand side of the table. The former consists of ordinary gas pipe, ¾ in. diameter, and for each of the nine cars is about 55 ft. in length. The rest of the piping required consists of three short lengths of half-inch gas pipe from the triple valve—one to the brake pipe, one to the auxiliary reservoir, and one to the brake cylinder. The ends of the large pipes are shown at p in the perspective view projecting above the table, a ¾ in. stop-cock is introduced near the end of each close to the connection with the flexible hose coupling pipes. At the end of each of these short lengths is placed one half of the malleable iron coupling by which the whole line of piping along the train is made continuous. Each half is a duplicate of the other, and is provided with a projecting lug and corresponding recess, which fit into each other to connect the coupling. The passage in each part from the nipple to which the rubber hose is attached, is thus deflected downward in one half, and upwards in the other, each terminating in a space in the middle. The surfaces of the coupling through which communication is made are not in contact, but are separated slightly, by the interposition of a rubber ring placed in a recess in each half of the couplings, and projecting above the surface. In the space beneath this rubber ring and the bottom of the coupling is introduced a so-called coupling packing expander, the lower part of which terminates with a spindle fitting into a seat in the coupling, and the upper part presses against the rubber. This expander is made open so as not to interfere with the free passage of the compressed air which forces the rubber rings together, and makes a perfect joint. In the event of the train so equipped breaking into two, the couplings yield, and the air escaping through the opening, sets on the brake. Originally these couplings were made of brass, but those were so freely stolen that malleable iron is now used instead

One series of the short length of half-inch gas piping passes from one or other of the lines of the three-quarter inch main coil to the triple valve, which is placed on the top of each auxiliary reservoir. Figs. 3 and 1 show this. In the former it will be seen that the smaller pipes pass underneath the bracket on which each of the brake cylinders stand, and descend on the outer side of the table into a **T** junction on the larger pipe, each of these junctions being stepped back to the succeeding line of the coil. It will be seen at once that this arrangement represents the disposition of pipe and reservoirs under a train, supposing them to be stretched out into a continuous line. The triple valve is attached to the top of the reservoir, with which it has free communication. Finally, another half-inch pipe leads from the valve to the brake cylinder. In the drawings, o is the half-inch pipe from the main pipe, n is the pipe to the brake cylinders, $s\ s$, $m\ m$, etc., are the triple valves, and $l\ l$, etc., the auxiliary reservoirs. The triple valve, one of the most ingenious details of the apparatus, is shown to a larger scale in Fig. 6, and requires some careful description. By its means the brakes are entirely controlled with the expenditure of a very small quantity of air at each application, and the pressure on the brake shoes is regulated at will. It consists of a casting, the main body of which contains two cylinders, A and B, Fig. 6, one below the other; the former being of the larger diameter. Forming a part of this casting is the socket of a four-way cock 17, four branches from which lead as follows: E, from the main brake pipe, one end of the half-inch pipe o being screwed into E; F, to the brake cylinder, one



THE WESTINGHOUSE RAILWAY BRAKE EXHIBIT.



THE WESTINGHOUSE RAILWAY BRAKE EXHIBIT.

end of the half-inch pipe *m* being screwed into F. The two other passages are *a*, Fig. 6, leading from E through the plug of the four-way cock down the outside of the cylinder A, and into this at the bottom through the small hole drilled through the cover 6, which is screwed into the cylinder as shown. Finally the passage *b* runs from F through the other opening in the cock 17, and enters the smaller cylinder B. Immediately below the passage *b* there is a second opening into the cylinder B, and marked *d* in the section. This opening is in free communication with the air. At a point made by the intersection of the center line of the passage E, and center line of the cylinders A, B, is another opening which is indicated by a dotted circle in Fig. 6. This shows the connection between the valve and the auxiliary reservoir. No. 4 is a piston free to travel in the cylinder A, and provided with an upper stem traversing the cylinder B, and entering a passage formed in the screwed plug 5, which closes the upper end of cylinder B: this passage serves as a guide for the stem of the piston 4. Just below the under side of the plug 5 (in the position shown in Fig. 6), a collar is placed upon the stem 4, and lower down it is enlarged by having a shoulder formed upon it, this enlargement extending down to the body of the piston. In the center of the latter a vertical hole *g′* is drilled, and through the enlarged part of the stem a horizontal hole 2 is also formed, and *g′* and *h* are placed in communication by means of the pin hole which forms an extension of *g′*. Between the shoulder and the collar on the stem 4, a slide valve 12 is placed, which either puts the passages F *b* and *d* into connection (the position shown in Fig. 6), or covers *d* and places F *b* in communication with the cylinder B, and therefore with the auxiliary reservoir. The valve is kept up to its work by a light spring at the back, bearing against the side of the stem 4. Turning now to the bottom of Fig. 6. The upper surface of the screwed cover 6 has a shallow recess formed around it in which a leather ring 10 is placed, and there is also a deep annular recess into which the passage *a* opens. Into the central portion of the casting 6, a stem 7 is introduced, with a collar near the upper end that fits the cylindrical chamber as shown. At the bottom of 6 is screwed a piece 9, with a central passage, forming a guide in which the stem 7 can move. The space between the upper face of 9 and the under side of the collar on 7 is occupied with a coiled spring 8. The upper part of 7, that is that part which projects into the cylinder A, terminates in a small plunger *g*, which fits the vertical opening *g′* on the piston 4. A needle is screwed into this plunger to keep the small aperture between *g′* and *h* free from dirt.

Thus far the organism of this detail. We have now to consider the manner in which it operates. Compressed air being admitted from the main brake pipe through E, passes down the channel *a* and enters the cylinder A, and raises the piston 4, until it is clear of the plunger *g*; the valve 12 is of course also raised and the brake cylinder is in communication with the atmosphere through the passage *d*. So soon as the piston 4 is raised off the plunger *g*, the compressed air passes through the passage *g′* in the cylinder B, and thence through the opening shown in dotted lines to the auxiliary reservoir Brake pipes, cylinders (A and B of Fig. 6), and reservoir, are thus in equilibrium. But when it is desired to put on the brakes, the pressure in the main brake pipe and the pressure in cylinder A is reduced more or less completely, according to requirements, by opening a cock on the main brake pipe, and making the communication with the air. The superior pressure in B when this has been done, at once causes the piston 4 to descend, carrying with it the valve 12, which shuts the port *d* and opens the auxiliary reservoir to the brake cylinder, through the passage *b*, which is opened by the downward travel of the valve, the piston of the brake cylinder being driven forward and the brakes put in action. To release the brake, compressed air from the principal reservoir is again admitted into the main brake pipe and thence into the cylinder A, when the piston 4 is again driven upwards, the valve 12 is brought back to the position shown in Fig. 6, and the brake cylinders are placed in communication with the air. Although this triple valve requires considerable explanation to render its arrangement and mode of working quite clear, it is far from being a complicated detail, does not get deranged, judging from a long and very large experience of it upon American railroads, and it is very prompt in its action, as we shall see further on when we arrive at a consideration of the relative performances of the automatic and the vacuum brakes.

In order to prevent an automatic action of the brake when the engine is detached from the train through the leakage of air from the brake pipe, a small valve is introduced on the pipe between the opening F and the brake cylinder. It consists of a case with a screwed cap and a rubber face, a central opening being made through the face and the bottom of the cap. Within the case is a valve, against the lower part of which the air pressure acts. This valve is not a tight fit in the case, so that when there is a slight reduction of pressure arising from leakage or any other cause, the air enters slowly and passing round the valve escapes to the atmosphere, but when the brakes are operated the valve is forced upward against the rubber seat, and all escape is prevented. When the plug 17 (Fig. 6) of the four-way cock is turned one quarter round, the ports E and F are brought into connection, and the air passes directly from the brake pipe to the brake cylinder for the direct application of the brake without changing any of the other parts. The various pipes are attached to the frame of the carriage by suitable clips. In operating the brakes upon a train, when the pipes have all been coupled up, the cock at the end of each length of pipe (*t*, Fig. 3) is opened, excepting that at the end of the train, and these cocks have to be closed when it is desired to disconnect any of the carriages.

The arrangement of the air pump consists of two cylinders, one placed below the other, the upper being the steam and the lower the air cylinder; the pistons working in them are on the same rod, the upper part of which is hollow, to give place for a rod, connected at the top of the steam cylinder to a valve, the movement of which controls the admission of steam. The piston in its downward stroke imparts a slight movement to the valve through the rod, admitting steam to a small cylinder containing a piston and rod extending as far as the whole length of the main cylinder, and terminating in steam passages at the top and bottom. These

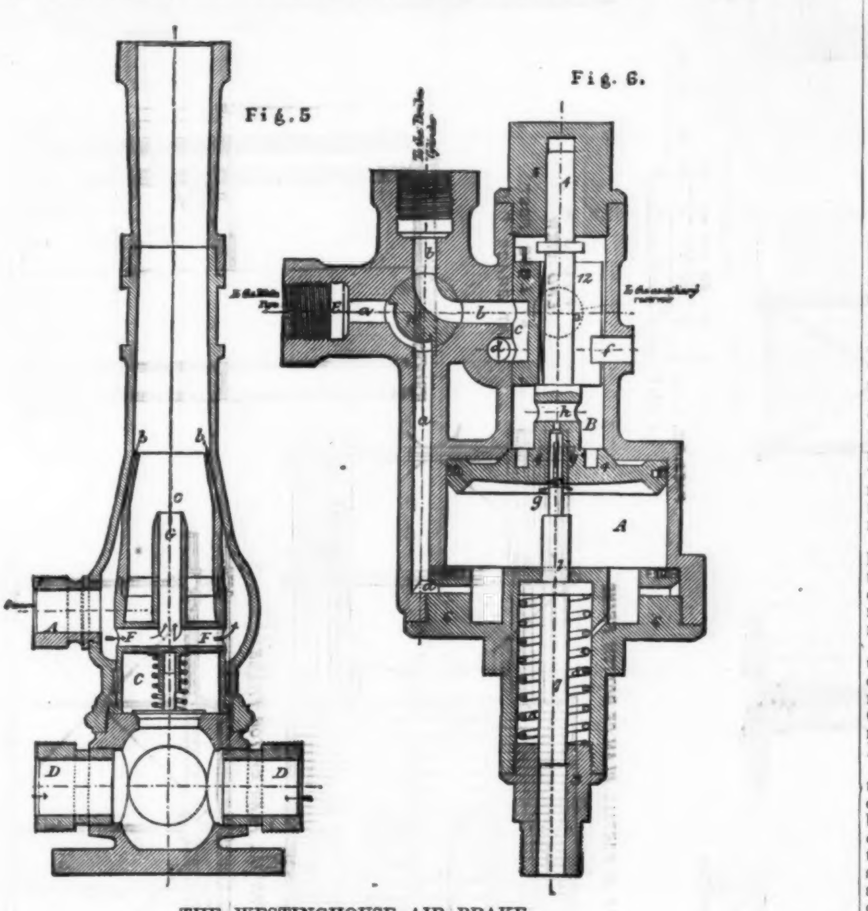
passages are controlled by piston valves placed on the rod, and it is by the travel of these valves, moved by the piston in the small cylinder, which is controlled by the slide valve, that is actuated through the hollow piston rod of the main cylinder, that the apparatus is driven.

2. *Serial Compressing Apparatus.*—The serial compressing apparatus which forms a part of the Westinghouse exhibit at Philadelphia is shown in Figs. 1, 2, and 3. It is employed there instead of the usual single air-pump engine and reservoir required for a train equipment, and consists of a large central reservoir d which receives the compressed air from the pump a^1, the third of the series a^2, a, a^1. The diameters of the air pumps of this series are 10 in., 6 in., and 4 in. respectively, the strokes of the first two being 13 in., and of the third 10 in. The arrangement of each is exactly similar to that referred to above. The steam cylinder of each pump is 6 in. in diameter. Two reservoirs c and c^1 are in communication with the pumps a^2 and a, the former forcing air into c at a pressure of 25 lb. per square inch. The pump a draws its supply from c and forces it into c^1 at a pressure of 115 lbs. per inch, while the pump a^1 drawing from c^1 delivers it into the main reservoir at 220 lbs. per square inch. It is needless to add that this pressure is far in excess of that required for working the brake, for which 75 lbs. or 80 lbs. in the reservoir is ample. The perspective view as well as Figs. 2 and 3 show the arrangement of pumps, reservoirs, and pipes. Of the latter there are three series. 1. That of the steam and exhaust pipes to the pumps; 2, that of the air pipes to the reservoirs; 3, that from the central reservoir to the coil. In the drawings e is the steam pipe supplying the three cylinders a^2, a, a^1, and f is the exhaust pipe common to them, and the arrangement of these are all clearly shown, as well as that of the second series of air pipes. Of these the first passes from a^2 to c, Fig. 3, the second from c to a^1, and thence around the central reservoir, to c, Fig. 2, and the third from a^1 to the central reservoir, Fig. 2. The three-way cock by which the brake is manipulated is shown at g, Figs. 1, 2, and 3, as well as the third series of piping, making the communication between the reservoir and the coil of brake pipes. By means of this cock the supply of air is shut off from the brakes or given to them, or the pressure in the brake pipes is relieved at pleasure. The small pipe, shown parallel to that joining up the brake pipe in Fig. 1, is the waste pipe through which the air escapes when the brakes are applied in the exhibit.

In Fig. 4 is shown a section of one of the auxiliary reservoirs, from which it will be seen that the ends are dished to give them additional strength, and for convenience in manufacture.

The foregoing description will, we believe, convey a clear idea of the arrangement of the Westinghouse brake, as well as of the special method in which it is exhibited at the Centennial. It should be especially borne in mind that the serial compressing apparatus is entered as a separate exhibit from the brake appliance, and merely used to operate the latter, on which occasion only the ordinary working pressure is employed, the maximum compression mentioned above being exhibited to show the efficiency of the pumps for other than railway brake purposes.

3. *The Vacuum Brake.*—This section of the Westinghouse exhibit represents the appliance for a train of exactly similar extent to the one just described, and it is clearly shown in the drawings. The Westinghouse Air Brake Company own the patents under which this brake is made and worked in the United States, but its decreasing application in that country practically confines the business done there with it, to the repair and renewal of the perishable material upon which it depends for its action, and trifling applications to new stock for lines on which the vacuum system is in use. The description of this brake is much simpler than that of the automatic, and its efficiency bears about an inverse ratio to the magnitude of its appearance as compared with the air brake. Briefly, it depends upon the exhaustion of air through a series of large pipes from a number of collapsible bags—two under each car—by means of a powerful ejector, placed on the engine in practice, and on the top of the large reservoir at x in the exhibit. This ejector is shown in section to a large scale in Fig. 5. It consists of an outer pipe or casing near the bottom of which is a branch A to a steam pipe. This case is screwed to a base with two branches D D, which are in connection with the brake pipes. Within the casing is a nozzle c resting on the base above mentioned, and fitting tightly to the lower part of the case. This nozzle has an inner and central nozzle G with two openings F F at the bottom. In the lower part C is placed a check valve kept in place with a light spring and closing thus the exit in the top of the base. When steam is turned on from the boiler through A, an annular jet passes into the casing around b b, and a central jet through G produces a powerful current, and exhausts the air in the brake pipes through D, this air passing through the check valves in C, and through suitable openings b b into the casing. The action of the brake thus depends upon the partial vacuum obtained by the ejector, this being utilised by means of a double row of pipes 1¼ in. diameter inside, running along the whole length of each car. —*Engineering.*



THE WESTINGHOUSE AIR BRAKE.

A STATION INDICATOR.

AN invention which meets a want long felt by the travelling public has just been patented by Conrad Jenson, an enterprising young German, of Boston, in the form of an indicator for steam cars, by which the various stations to be stopped at can be placarded. Travellers by railroads frequently are at a loss to understand the names of places as called out by the brakemen on the cars. By the invention in question all this annoyance is obviated. The indicator consists of tablets, about 18 by 6 inches, bearing the names of the different stations, each tablet arranged in the order of stopping. They are mounted on a sliding hinge made of thick wire, and fold up something like a book, and are held in place by a lever, which is the key of the whole arrangement. Connected with that part of the lever nearest the tablets, are two flat pieces of metal, each a little over an inch in length, one an eighth of an inch inside the other, and both extending in the form of an angle instead of running perpendicular to one another. Directly above this with the lever is connected the cord, which runs through a tube the length of the car, and so connected on the rear as to be worked from the platform if necessary. By pulling the cord, after the train starts from a station, the name of the next stopping place appears.

The first public trial of the indicator has been made on the Fitchburg Railroad. It performed all that was claimed for it. This company proposes to have indicators on all their cars, and already have fitted up one train with them. The company will have them operated either from the platform or in the car, by the brakeman, although the cord which connects with any one of them can be attached with those of others, and thus every indicator in the train, no matter how many cars, can be worked by one man, at one time, and in any part of a train.—*National Car Builder.*

THE ROLLING OF SHIPS.

AT a recent meeting of the Society of Engineers, London, Mr. V. Pendred, President (in the chair), a paper by Mr. Wm. McNaught, on "The Rolling of Ships," was read by the secretary. The author first alluded to the heavy straining caused to ships by rolling. He showed by diagrams that the point around which a ship was rotating in rough water was a point (stationary for the instant) where the three motions, rotation, lifting or lowering, and drifting, destroyed each other. He showed that under certain concurrences of these three motions, the turning moment of the wave force would be very great, so as to account for heavy lurches. Mr. McNaught observed that lifting or drifting could not be prevented, but rotation could be controlled to a great extent, by the use of one or two balanced rudders, under the bottom of the ship, so constructed, as to be drawn into the ship when not wanted, or when in shallow water. These steadying rudders were proposed to be worked by an attendant, who would turn them, so that their inclined surfaces would always be acting in opposition to the angular motion of the ship. By this means the oscillation might be kept within four or five degrees, except occasionally, from an extraordinary concurrence. The effect of such a concurrence could be destroyed by the steadying rudder, during two or three double rolls. The author gave a formula for calculating the force on the rudders, that would destroy four degrees of oscillation in two double rolls, from which he calculated that H. M. S. Shah would require two rudders, each 1 foot broad by 4·68 long, and H. M. S. Devastation, a rudder, 1·5 feet broad by 5·3 feet long. When making seven knots a ship of 3,000 tons would require two vanes, 6 inches broad by 2·32 feet long. The apertures in the bottom of the ship would require to be but little larger than the breadth of the vanes. If the two rudders were placed at opposite ends of the ship the author observed that they would powerfully assist her steering, by giving them an opposite inclination to each other, which property might be invaluable on a lee shore or in other emergencies. He did not pretend that they could prevent disasters at sea. By the doctrine of chances extraordinary and fatal concurrences would certainly happen, but their probability might be diminished to an unknown extent.—*Engineering.*

FIELD RAILWAY FOR RAPID CONSTRUCTION IN WAR TIME.*

By Mr. J. B. FELL, C.E.

FIELD railways are now recognized as being amongst the most important appliances in modern warfare, but hitherto it has been found impossible to construct them with such rapidity as to be available for the transport service at the commencement of a war.

The Crimean war was far advanced before the Balaclava railway was finished. The Abyssinian war was over about the time that the railway from Zoolla to the Koomaylee pass was complet d. The railway made by the German army in the Franco-German war was not ready for working until within a few days of the fall of Metz, when it became useless. The railway sent out to the Gold Coast was absolutely useless, and the difficulties and danger of the expedition were much increased by the want of the means of transport, which the railway might have afforded for the first thirty miles on the road to Coomassie. Consequently, the usefulness of field railways, to a great extent, depends upon the rapidity with which they can be constructed.

The cause of the partial failure of the military railways hitherto made is to be found in the impossibility of executing the works of which ordinary railways consist, such as cuttings, embankments, and masonry, with the rapidity necessary for laying down a field railway at the commencement, or even in the early part of a war.

Our Government have, therefore, had under consideration the practicability of adopting some other method of construction, by which the difficulties hitherto experienced might be overcome. For this object the Royal Engineer Committee at Chatham have carried out a series of experiments at the camp at Aldershot, of which Captain Luard, R.E., and the writer of this paper had the charge.

The experimental railway consisted of a succession of timber viaducts, which supplied the place of earthworks, culverts, and bridges, and which, when the materials had been prepared, could be erected with great rapidity. The conditions the committee desired to have fulfilled in the trials were, that an engine not exceeding six tons weight should take a train of 30 tons up an incline of 1 in 50, and travel at an average speed of ten miles, and maximum of twenty miles per hour. The wagons were required to carry a load of three tons dead weight each, and from 300 to 500 cubic feet of bulky goods, such as tents, hay, and commissariat stores. A seven-ton siege gun was to be carried on two wagons, and it was to be shown to be practicable to construct one mile of railway per day over such ground as was selected by the committee at Aldershot by the labor of 500 men.

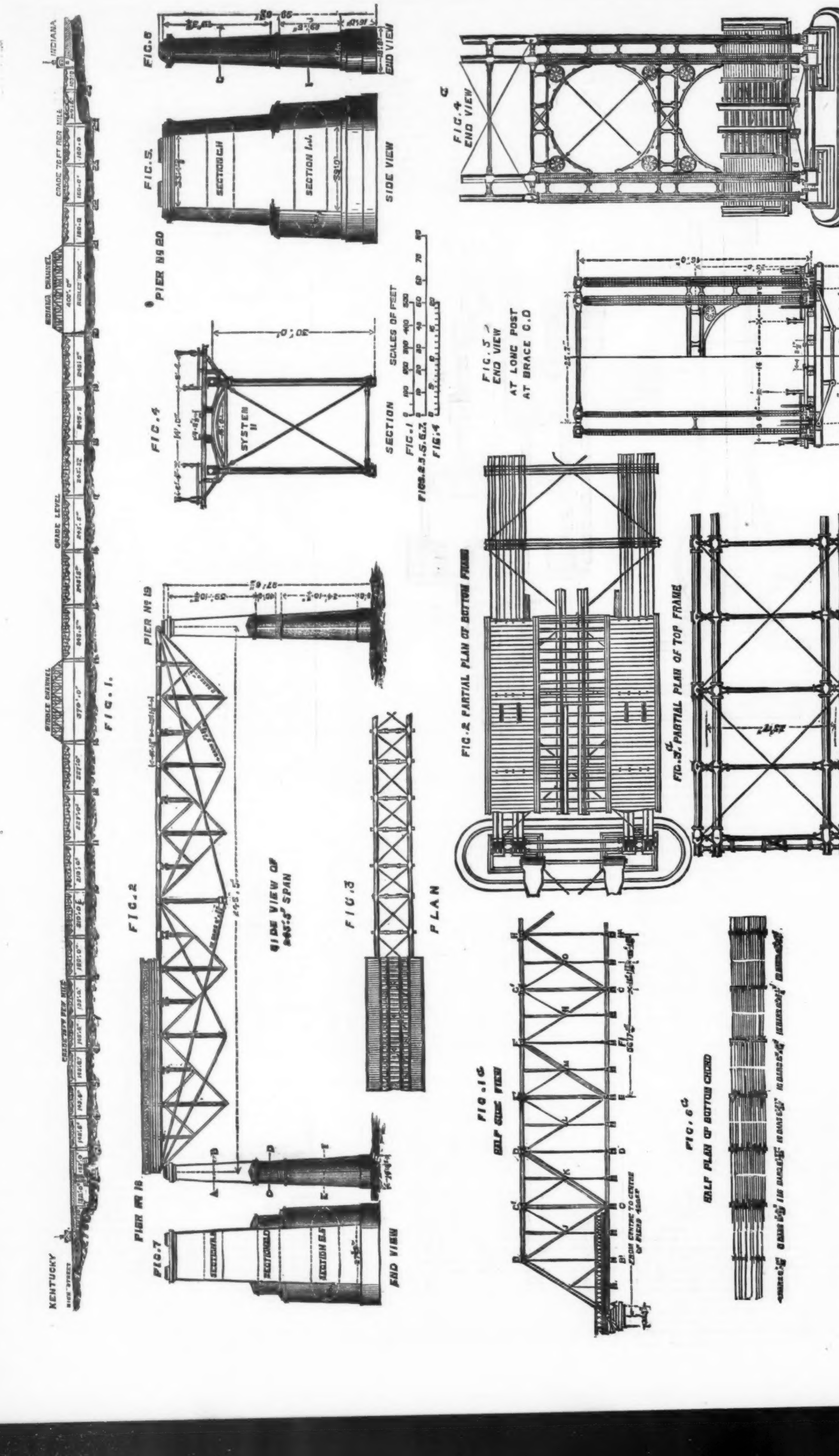
The experimental railway was one mile in length, the gauge 18 in., steepest gradient 1 in 50, the sharpest curve 3 chains radius, and one of the viaducts was 660 ft. in length, and 24 ft. in height. The structure was of a simple form, and consisted of two beams, which were bolted to a kind of trestlework supports, which were sunk to a depth of 12 in., and firmly fixed in the ground. The rails being laid on the beams completed the railway, for the construction of which no other than military labor was required.

The experiments occupied, at intervals, a period of twelve months, and the committee came to the conclusion that the result of the trials had proved that the above-named conditions had been, in every respect, complied with and exceeded. It had been shown that a single line of field railway, constructed on the system employed at Aldershot, would be capable of carrying ammunition and commissariat stores sufficient for the supply of an army of 100,000 men; that a double line, and day and night service, would be capable of supplying an army of 300,000 men; that a single line of railway could be made over ground similar to that at Aldershot at the rate of two miles a day by 500 men; and that, if it should ever be required, it would be possible to construct a field railway at the speed at which an army of 100,000 men could march.

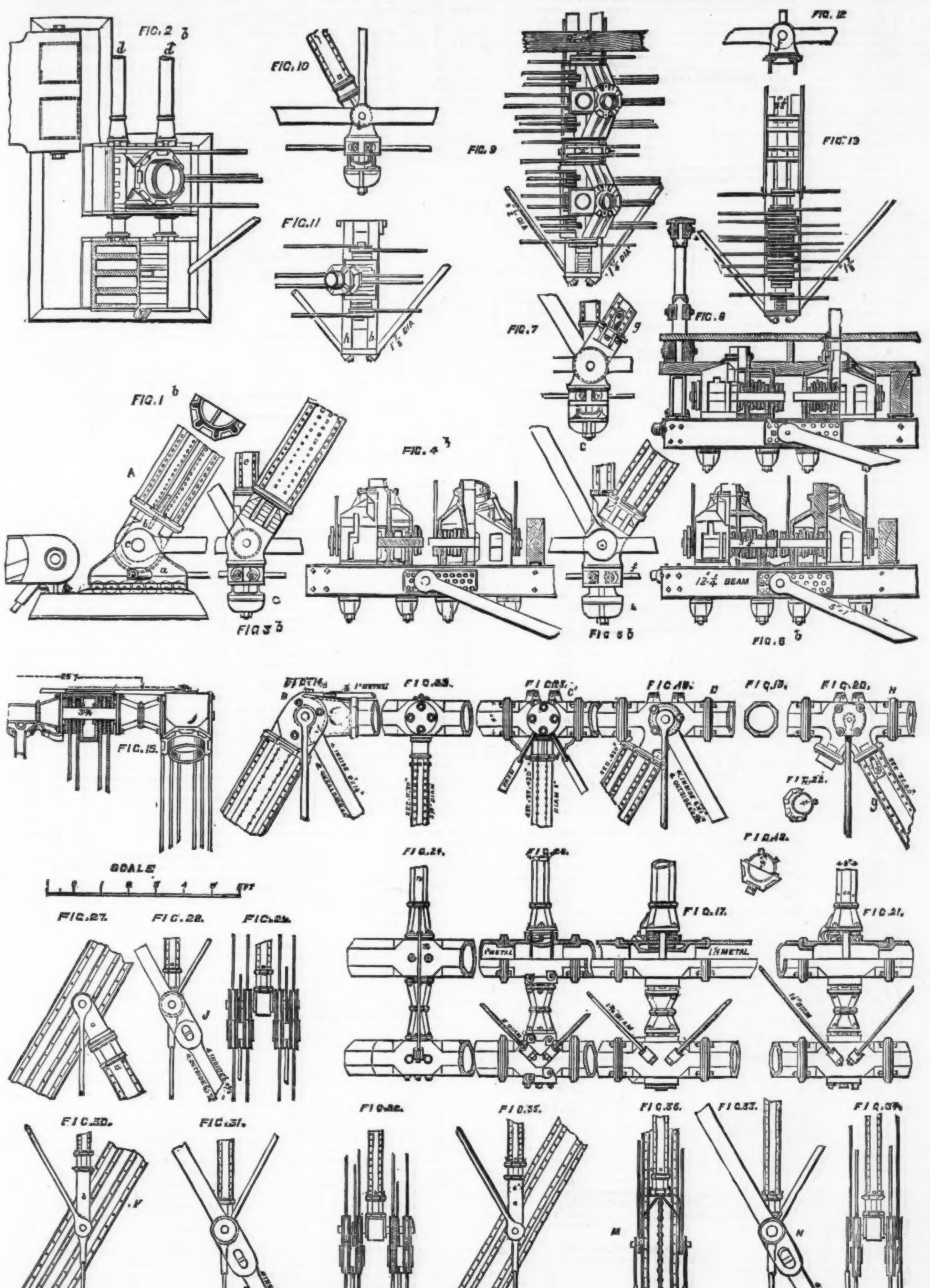
Besides the Royal Engineer committee, a considerable number of military and civil engineers, both English and foreign, were present at the experiments. In the course of the trials, and subsequently, improvements have been made in the form, materials, and details of the structure, by which the carrying powers and the efficiency of the railway have been considerably increased. An ordinary transport ship, accompanying an expedition, would carry the materials and rolling stock for twelve miles of railway, and the Great Eastern steamship would carry from seventy to eighty miles. The cost of the mile of railway at Aldershot, with sidings, stations, and rolling stock, was £3,500, and a similar railway of 2 ft. 6 in. or 3 ft. gauge, to be worked by engines of 10 tons weight, and wagons carrying loads of 6 tons each, could be made for about £5,000 per mile, the cost of erecting included.

Although a railway made on the system above described could not be expected to carry the same amount of traffic as one on the 4 ft. 8½ in. gauge, made in the ordinary way, it would be quite capable of performing the whole of the transport service for a large army in the field, in a more efficient manner than it could be done by horses, at a much less cost to the country, and, in the opinion of military authorities, the value of such an improved method of transport in war time could scarcely be over-estimated.

* British Association, Section G.



CINCINNATI SOUTHERN RAILWAY CO.'S BRIDGE, AT LOUISVILLE.



CINCINNATI SOUTHERN RAILWAY CO'S BRIDGE OVER THE OHIO, AT LOUISVILLE.

OHIO RIVER BRIDGE, LOUISVILLE, KY.

WE illustrate this week the railway iron bridge constructed by the Keystone Bridge Company, for the Cincinnati Southern Railway Company, over the Ohio river at Louisville.

Fig. 1 is a general view of bridge as completed. It is 5,294ft. long, divided into the following spans from center to center of piers:—Kentucky abutment, 32ft. 5in.; two spans of 50ft., 100ft.; one pivot-draw over canal, 264ft.; four spans of 149ft. 6in., 598ft. 4in.; two spans of 180ft., 360ft.; two spans of 210ft., 420ft.; two spans of 227ft., 454ft.; one span of 370ft., 370ft.; six spans of 245ft. 5in., 1,473ft.; one span of 400ft., 400ft.; three spans of 180ft., 540ft.; one span of 149ft. 6in., 149ft. 6in.; one span of 100ft., 100ft.; Indiana abutment, 32ft. 5in.; total, 5,294ft.

The grade of track approaching the bridge on the Kentucky side coincides with that of High street at its crossing; from this point it ascends at the rate of 76ft. per mile to pier No. 13, a distance of 2,500ft. from the street, and 2,229ft. from back of abutment; from this pier, where the elevation of track is 95ft. above low water, the grade is level to pier No. 21, a distance of 2,243ft.; here the elevation of rack abovet low water is 101½ft.—low water mark of the Indiana channel being 6½ft. below that of the middle channel. From pier No 21 the grade descends at the rate of 76ft. per mile for a distance of 700ft., to the Indiana abutment, where it has an elevation above the river bank of 35ft.; from this point it descends at the same rate till the natural surface is reached, at a distance of 2,500ft. from the abutment.

All of the foundations are on solid rock, with the exception of the abutments and shore piers 0 and 25, which are on hard clay. The foundations from 1 to 11, and from 22 to 24 were put in during the season when there was no water in that part of the river. The foundations for piers 12, 13, 14, and 15, are in smooth water, and those for piers 17, 18, 19, 20, and 21 in the rapids; the velocity of the water in this part of the river being, during the best working season, from 14 to 20 miles per hour. The difficulty of securing the foundations of these piers, as well as of carrying on the masonry and erection of scaffolding, arose mainly from the want of permanent accessibility to the work, the sudden changes of the river rendering it impossible to supply material for any great length of time by one fixed plan. To meet this difficulty it was necessary to be always prepared to transport men and materials to the work, either by water—with steamboat and barges—or land—by means of trestles and tracks. Only in extreme low water could temporary trestles be maintained; these were frequently swept out by rises in the river, which for three or four days would render it possible to use barges. Upon the subsidence of the boating stage a trestle would have to be resorted to. These temporary tracks were constructed from pier No. 11, on Corn Island, a low ledge of rock which served as a secondary base of supplies, being secure from the smaller rises. The line of track was parallel to center line of bridge, and about 40ft. above it. The plan which best withstood the effects of small rises was that in which the stringers were supported on cribs 6ft. square, placed from 36ft. to 40ft. apart between centers, with their corners against the current; these were secured in place first by being filled with stone, and then by four-inch bolts, which passed one through each stringer to the rock bed of the river, to which they were secured by split ends with wedges; the stringers were in pieces the length of the span. Some of the cribs were 14ft. high, the clear elevation of stringer above low water being about 4ft. This plan of track has stood in sections 200ft. or 300ft. long, with 6ft. of water over it, having been covered before any drift had an opportunity to lodge. At certain stages of the river it was impossible to approach some of the piers either by trestle or boat. These circumstances largely increased the cost of the work. The foundation for pier No. 17 was the last put in, and was obtained with particular difficulty, on account of the existence of fissures in the rock, which rendered the necessary pumping out of the coffer-dam difficult.

The aggregate masonry is 29,779 cubic yards. Fig. 7 is a side view of pier No 18, supporting 245·5ft. span Fink truss. In Fig. 7 the form of section at different heights is shown. Figs. 5 and 6 are different views of pier No. 20, supporting 400ft. span. The cut-water caps and copings are bush-hammered. The masonry is built of compact limestone, in courses varying in thickness from 12in. to 2ft. 6in. The masonry has been constructed throughout in accordance with the specifications in contract for the same herewith published.

With the exception of the channel span, all of the superstructure is placed below grade, Fig. 1. The below grade or deck portion (excepting the canal draw, which is entirely of wrought iron, on the triangular plan) is on the plan of Fink's suspension truss; in these spans the chords, post-shoes, cross-struts, and floor-beams (arched with tie-rods) are of cast iron, the posts wrought iron Phœnix columns, and the tension members of the best wrought iron. The weight is supported by two trusses, placed 16ft. apart, between centers; these trusses rest at the piers on planed surfaces, on which they are free to move when affected by changes of temperature. The over grade or through portion, consisting of the channel spans, respectively 370ft. and 400ft. long, is a modification of the triangular plan. This modification consists in the introduction of secondary or auxiliary trusses, Fig. 1, thereby rendering it possible to use an economical length of panel in the primary triangular truss, and by fixing the braces at their middle effect a great saving of material. In these spans the weight is supported by four trusses (Figs. 1, 2, 3, and 4), two on each side of roadway. The entire bridge is, in addition to its own weight, proportioned for a rolling load of 2,600 lb. per lineal foot. With this maximum load the factor of safety in the cast iron chords is from 6 to 7, and in the wrought iron braces from 5 to 6, by Hodgkinson's formula.

The strain in the wrought iron tension members is varied according to their position and duty; for example, the suspension and small truss bars of the channel spans, which are subjected to a maximum load at the passage of each train, have with this load a strain of from 7,000 lb. to 8,000 lb. per square inch; while the bottom chords of these spans, and the main systems of the suspension trusses, which rarely, if ever, are subjected to the calculated maximum strain, are proportioned for a strain of 12,000 lb. per square inch. The other tension members of the bridge are proportioned for intermediate strains, 7,000 lb. being the least and 12,000 lb. the greatest strain with a full load. To illustrate more fully the character of the trusses composing the superstructure, the longest spans of each kind of truss have been selected, viz., the 245·5ft. Fink suspension and 400ft. modified triangular spans; the latter being the longest truss girder yet completed in America, is of general interest, and will be considered more in detail than the suspension truss, with which the engineers of this country are more familiar.

Fig. 2 is a side view, Fig. 3 a plan, and Fig. 4 a section of the 245·5ft. span. In this span arched floor-beams with tie-rods carry the load to the trusses, which are placed 16ft. apart, and have a depth of 30ft. These floor-beams, extending under the chord, form part of the post, and at the same time act as struts in the system of lateral bracing; they are securely bolted both to chord and post-cap. The tie-rods, being put in while hot, have a slight strain when the beam is unloaded. The chords are formed of 16in. cast iron tubes, octagonal on the outside and circular on the inside; they are cast in sections the length of two panels, and connected at joints by sockets and tenons, which are bored and turned to fit. The posts are wrought iron columns, varying in diameter from 13¼in. to 8in., and in area from 45 to 9 square inches. The number and size of wrought iron bars are shown by the drawing. The roadway and footwalks are supported on six strings of 8in. by 16in. white pine stringers. Only the footwalks are floored over, the roadways used by trains, 14ft. wide, along the center line of bridge, being unplanked as a precaution against fire.

The quantities of iron in this length of span, average for the six spans, are as follows:—Cast iron, 213,061 lb.; wrought iron, bars, rods, pins, etc., 179,756 lb.; column iron, 37,188 lb.; total weight of iron, 430,005 lb. Weight of iron per foot of span, 1,776 lb.; weight of flooring—stringers, cross-ties, rails, foot-walks, railings, etc.—per foot of bridge, 630 lb. Total weight per foot of complete bridge, 2,396 lb. The deflection of this span under a train of four locomotives, weighing 200 tons at rest, was at the center 1¾in., and at the quarter posts 1¼in.

Fig. 1*a* is a half side view of the 400ft. span. In this the primary triangular truss A B C D E F G H, etc., is divided into seven panels of 56ft. 7¼in. each; to subdivide these panels the posts C C′, E E′, and G G′ are introduced, with the auxiliary trusses B J C″, C′ K D, etc. By these intermediate supports the divisions of the top chord are made 14ft. $1\frac{11}{16}$in., and by suspension bars from the points I, J, K, L, etc., the floor-beams are supported at the same intervals. The floor-beam next the pier is supported directly by the pier and point B′, the strut I B′ carrying the weight to B. Fig. 2*a* is a partial view of bottom frames, with and without foot-walks. Fig. 3*a* a partial view of top frame. Fig. 4*a* is an end view in a direction perpendicular to plane of braces, showing arrangement of foot-walks and roadway. Fig. 5*a* is a half section in front of long posts C′ C, and half end view of brace C D. Fig. 6*a* is a plan of bottom chord for one pair of trusses.

The distance between centers of trusses forming the pair is 41in., and that from center to center of pairs 25ft. 7in. The depth of truss from center to center of chords is 46ft. The trusses on either side of roadway are now securely connected by bolts and struts; but before being thus connected each was allowed to support its own weight, and assume its natural camber, uninfluenced by any connection with its neighbor. By this precaution the possibility of undue strains from inaccuracy of workmanship was avoided. It is of interest to know that when thus swung independently no perceptible difference could be observed in the camber of the four trusses which, while supporting each its own weight, were bolted together without reaming or chipping. The manner in which the weight of the flooring and moving load is carried equally to the trusses is shown by Figs. 7 and 8, the concentrated weight at the pin being supported equally by the suspension rods on each side. The top chords are cast iron tubes, with an exterior diameter of 14in., having an octagonal outside and circular inside form; they are reduced in section from middle to end of span in proportion to diminution of strain; the maximum thickness of metal being 1½in. and the minimum 1in. The braces and posts are close-riveted wrought iron Phœnix columns, varying in diameter from 5½in. to 17in., and in section from 5·7 to 60 square inches. The wrought iron—bars, rods, etc.—has an ultimate strength of 60,000 lb. per square inch. The track stringers, consisting of four pieces of white pine 8in. by 16in. each, are supported by trussed 12in. I beams, as shown in Fig. 5*a*. The cross-ties extend to the edge of the foot-walks, and are supported at their ends by longitudinal pieces, as shown in Fig. 5*a*.

Figs. 1*b* and 2*b* show the foot of the end brace A B, with its pier bearing the weight being carried to the masonry through the cast iron pier-box, which also serves as a seat for the adjoining 245·5ft. span Fink truss; 5in. cast iron rollers at each end allow the span to readily adjust itself to varying loads and temperatures. The steel pin *c*, 4½in. diameter, the brace-shoe *b*, and the roller plate *a* form a hinged joint; double struts *d d* connect the opposite sides. Figs. 3*b* and 4*b* are respectively the side and end views of bottom chord connections at C, foot of second brace; *e* is the foot of long post C C′. Figs. 5 and 6 show bottom chord connection at E—foot of third brace. Here *f* is a side hill washer at the end of trussed floor-beam for bottom diagonal bracing. Figs. 7, 8, and 9, show bottom chord connection G—foot of center braces C H; the strap *g* supplies all the counter bracing requisite, the weight of bridge in comparison to moving load being sufficient to neutralize all counter-strains from partial loads beyond the center braces. Figs. 10 and 11 show the connection of strut B′ I with bottom chord, *h h* being the floor-beam, and *i* the connecting casting. Figs. 12 and 13 show connection D′, bottom chord, the lug of casting *j* causing the floor-beam to act as a strut for the bottom system of diagonal bracing. The connections at F bottom chord, and H′ are similar to Figs. 12 and 13, except that their bars are ⅜in. thicker. Figs. 14 and 15 show the end of top chord B; *k* is the top lateral rod, and *l* the suspension rod. Fig. 16 is a side view, and Fig. 17 a plan of upper chord connections at D—top of brace C D. Fig. 18 shows section of top chord. The connections at F top of brace E F—are similar to Figs. 16 and 17. Fig. 19 is a half section of brace, with form of seat. Figs. 20 and 21 are different views of center joint H of top chord; the straps *g* here shown constitute the only provision required for the counter-strains. Fig. 22 is a half of brace section, with half plan of seat. Figs. 23 and 24 show chord connections at top of post for auxiliary truss B J C—Fig. 1*a*. The rod *m*, with strut *n*, connect this point with top system of lateral bracing—see Fig. 3*a*. Fig. 25 is a side view, and Fig. 26 a plan of upper chord joint at top of long post C C′, at this point; the tension bars of auxiliary truss pass through the chord join-box, and are adjusted with screw ends. Fig. 27 shows the connection of strut I B′ with center of end brace. Figs. 28 and 29 show connection of small post with middle of tie B C. Anticipating that unavoidable inaccuracies of workmanship would cause the trusses to hang with different camber, this point was provided with an adjustment by which the camber of the four trusses could be made the same, and their permanent connection thereby rendered simple; the practical results, however, proved these precautions unnecessary, no change in the computed length of the ties being necessary to secure uniformity in the camber of the several trusses; this adjustment for both the 400ft. and 370ft. spans was introduced as a precautionary improvement in the original design—single pin connection—and in both spans it proved unnecessary. Fig. 30 shows the connection of small post with center of brace C D. Figs. 31 and 32 show connection at center of tie D E, and Figs. 33 and 34 at center of tie F G. Both of these ties were provided with an adjustment which proved to be unnecessary. Figs. 35 and 36 show the connection of small post with middle of third and center braces E F, and the connection at G H is similar.

The bottom system of lateral bracing may be understood by reference to Fig. 2*a*. In this system the floor beams and bottom chords are made to act as members by the lugs on bottom of brace shoes, and connecting castings at joints between shoes, these lugs being carefully fitted into the flanges of floor beams. The diagonal rods pass through the center of the intermediate floor beams, which they keep in line by a simple connection; these intermediate floor beams form no part of the bracing system. The top system of lateral bracing is sufficiently explained by Fig. 3*a*. The weight per lineal foot of 400ft. span, including floor beams and pier bearings, and exclusive of track stringers, cross ties, track, foot walks, and railings, is 3,502 lb.; without pier boxes and rollers, 3,378 lb. The weight of this span complete, with stringers, cross ties, track, foot walks, railings, and pier bearings, is 4,162 lb. per lineal foot; the total weight of iron of all, 1,395,447 lb.

The 370ft. span is built on the same plan as the 400ft., with one panel less; the primary triangular truss being divided into six panels of 61ft. 4in. each; the length of subdivided panel 15ft. 4in. The depth of truss is the same as for 400ft. span, viz., 46ft. The trusses forming the pair on each side of the roadway are 34 in. apart between the centers. The pairs are 25ft. apart between centers. The clear width is the same in both channel spans, viz., 20ft. 6in. The weight per lineal foot of the 370ft. span, including floor beams and pier bearings, and exclusive of stringers, etc., is 3,008 lb.; of span proper, without pier bearings, 2,877 lb.; and of the entire span, pier bearings, stringers, etc., 3,668 lb. Total weight of iron of all kinds, 1,113,338 lb. It will be observed that the weight per foot of the 400ft. span is considerably more than for the 370ft. span. This difference in weight is partly due to the longer panel of the 370ft. span, a condition favorable to economy of weight, and partly to the increased length of span. The deflection of the 400ft. span with a train of four locomotives at rest in the center, weighing in the aggregate 200 tons, is 1⅛ in.; and the deflection of the 370ft. span under the same load, 1 in.

The camber was put in these two spans by making each part longer or shorter than the calculated length by the amount which it would compass or extend under the influence of its maximum load; on this supposition, when the span is fully loaded, the camber should disappear. The result has been very nearly reached; the camber of the 400 ft. span, when light, being 2½in., and of the 370ft. span 3¼in.; a small margin having been allowed in both to insure a camber in case of irregularities. The elongation of the bottom chord of the 400ft. span under a train of loaded cars is, by actual measurement, $\frac{3}{16}$in. The camber of the suspension trusses was put in by calculating the length of the chains for a length of post less than the true length by the ordinate at that point. In fixing the amount of camber for each span, the design has been to make it such that under a maximum load the span would be straight.

The erection of superstructure was commenced in May, 1868, and completed ready for trains February 12th, 1870. From pier 0 to 12 the false-work rested directly on the rock-bed of the river; from pier No. 12 to Indiana shore it rested on cribs varying in height from 5ft. to 12ft. In the false-work of all spans, except the 400ft., cribs 6 ft. square were used, three to each trestle; they were filled with stone and bolted down to the river bed. These cribs served as an excellent platform on which to put together the trestles, which were raised in one full-length section—some 90ft. high—by a locomotive on the finished portion of the bridge, as well as reliable protection against small rises. The 400ft. span scaffolding was erected on five large cribs, each 14ft. wide, 50ft. long, and 10ft. high, filled with stone and bolted to the rock; they were sunk with difficulty in the following positions: The first 57 ft. from center of pier No. 20, Fig. 1, next 114ft. from first crib—making a span of 114ft. for flat boats and small craft; the third, fourth, and fifth cribs divided the remaining space into about 57ft. spans. On these five cribs trusses were erected and connected at the top, except the long span, by single post trusses; for the long span leaning trestles were erected from the cribs on each side at such an angle as to be connected at the top by the same length of truss as spanned the short openings; on the trestle thus erected to grade of track, the top trestle was raised 50 ft. high, and the ironwork put together. The ironwork for the 400ft. span was put together in twenty-one days, and for the 370ft. in fifteen days.

The 245·5ft. span between piers 19 and 20 was the last span erected. At this span the raising forces from each side of the river met, and had it not been for an unforseen accident to the false-work of this span, by which the completion of the bridge was delayed for two months, the force raising from the Kentucky end would have completed this span at the same time that the force from the Indiana end finished the 400ft. span, early in December, 1869. On the 1st of December all of the spans were in place except this; the false-work for it had been raised, the track connected on top, and everything was in readiness to put on the iron of the superstructure, when the river commenced to rise rapidly. As it was impossible to secure the ironwork before the water would reach its highest point, it was thought advisable to suspend the putting on of iron, weight the false-work with stone. and wait the action of the water and drift for a few days. On the morning of the 5th a light sail boat was blown from the channel, and lodged against the trestle, knocking out two cribs. The water was now beginning to recede, the cribs had done their work nobly, and everything promised an early resumption of work. These anticipations were soon turned to disappointment, for on the morning of December 7th a steamboat with a tow of barges started over the falls in the fog, missed the channel, struck the false-work, and knocked it down. The trestles carried with them the cribs on which they were supported, leaving a gap of 245·5ft., at the bottom of which was an almost irresistible body of water, having a velocity of 16 miles per hour and a depth of 16ft. The 400ft. span was hung on its bearings November 27, barely escaping this flood. The top false-work of this span was taken down and sent on shore, while the bottom, consisting of the five towers, was pulled over into the river, it being of great importance to open the channel to navigation with the least possible delay. A plan for replacing the lost false-work of the 245·5ft. span was immediately fixed upon, and the work carried out as fast as possible under the disadvantages of continual high-water and the unfavorable weather of December and January.

The plan of the new false-work was such as to do away with the difficult work of sinking cribs in the swift water as far as practicable. One crib, 14ft. wide and 50ft. long was sunk in the middle of this span, and filled with rock; on this crib three trestles were erected, one vertical and one leaning toward either pier; supported on offset courses near the bottom of each a trestle was erected, leaning toward one on the center crib, sufficiently inclined to be connected by a 50ft. truss on top, forming a huge straining beam of 122ft. 9in. span. On this trestle the iron work was put together; and the span swung on the 4th of February. As this false-work was about being completed there came a great rise, the water reaching the depth of 45ft. where the false-work stood; the cutwater of the crib was carried up on the center tower, so as to prevent a lodgment of drift, large quantities of which were guided through the two spans of 122ft. on either side of the crib. So much confidence was felt in the stability of the trestle that the putting on of the iron was commenced as soon as the trestle was ready, and the span completed when the flood had scarcely commenced to subside.

All of the work of sinking the crib and putting together of trestles was done from barges, which were anchored in place—with difficulty, on account of the smooth rock bottom. The crib was built in and fastened to a barge 15ft. wide and 90ft. long; the barge was then loaded with as much rock as she could float, in addition to the crib, then towed to the site, held in position by lines, and scuttled.

Upon its completion the iron work of the bridge was thoroughly painted with red lead, and the timber with oxide of iron, except hand railings, which were painted with white lead.—*The Engineer.*

DIRECT PROCESS FOR IRON AND STEEL.

By JACOB REESE.

MUCH has been said and written about the direct process in the manufacture of iron and steel; many attempts have been made and much money spent in demonstrating different theories conceived to be in the direct line of economical production of iron, all of which, so far as they deviated from the Catalan fire or the blast furnace, have met with signal failure; and yet, though many thoughtless persons not versed in metallurgical science grapple with the subject only to swell the number of failures, and thus cloud the thought with disgust, there is still a deep conviction in the minds of the more advanced metallurgists that in time some system will be devised by which the ores of iron may be reduced and manipulated into the different qualities of iron and steel in the same chamber and at the same heat.

It is not strange that all attempts yet made public for the production of iron in what is known as the direct process, have been by deoxidizing the ores in the dry way, *i. e.*, by deoxidizing them while in a roasting (solid) condition, because the ores are so deoxidized in the Catalan fire and also in the blast furnace. But in these processes the ores after being deoxidized are melted into a fluid condition, thus enabling the metallic iron to settle to the bottom, and the earthy matter contained in the ores to float on the surface as scoria. But in all the attempts at the direct process which have come to my notice the ores have been deoxidized in the dry way, and then welded together, including all of the silica and other earthy matter not capable of being climited at the low temperature of the processes; hence, the more perfectly such processes were manipulated, the more imperfect would be the resulting iron, because the more perfect and rapid the deoxidation, the more earthy matter would be balled up amidst the metallic iron.

About ten years ago the writer made a series of experiments at the Fort Pitt Iron and Steel Works, in Pittsburgh, with a view of determining the possibility of deoxidizing iron ores while in a liquid condition. The preliminary experiments were so encouraging that patents were taken out in the United States, Great Britain, and France; and, though it is not very flattering to the writer that in all the discussions on direct processes in the last ten years not a single allusion to his process has been put in print, still the matter is on record, and with every unfolding improvement in the manufacture of iron and steel the impression grows stronger and stronger in my mind that the fuel of the coming age will be gaseous, and that metallic oxides will be reduced while in a fluid condition. Conceiving that my process was not confined to iron alone, I made the general claim of reducing metallic oxides while in a fluid condition, and the title of the patents was, "Reducing Metallic Oxides," which may in a measure account for the fact that they have been neglected in metallurgical discussions.

As an explanation of the great delay, coupled with increased faith in the liquid process, I desire to say that, in addition to the trouble incident to the charge of a large works, at the time when my preliminary experiments were being made our works were consumed by fire, destroying my entire plant. Soon after the works were reconstructed and again in full operation, the war of the Rebellion broke out, thus requiring my undivided attention to the supervision of our business. At the close of the war I again prepared to continue the experiments on a larger scale, but before my arrangements were perfected the explosion of our works took place, with a distressing loss of life and property, the effects of which had scarcely disappeared when, to the horror of all, the panic like a thunderbolt came, bearing destruction through the land. During all this time, though at the helm from early morn until the shades of night, the memory of my earnest hope for a renewal of experiments in reducing metallic oxides while in a liquid condition by the use of suitable chemical gases at a high temperature has been vivid in my mind; and though it is not my purpose to fully describe my process at this time, I will give a short outline, from which the general features may be conceived.

In the experiments made in 1866 and 1867, I used an ordinary cupola blown by a Root blower; diameter of cupola, 30 inches; height from bottom to charging hole, 7½ feet; fuel, Connellsville coke; Iron Mountain, Lake Superior, and Champlain ores, singly or mixed, were crushed and charged in a continuous stream. The taphole was left open, from which the melted ore ran in one minute from the time it was charged in a constant stream into the converter, and was then kept in a fluid condition by the exit of the hot gases intercepted from the cupola. In the first experiments a stream of vaporized petroleum was then injected into the molten ore at a pressure of 100 pounds to the square inch. These charges chilled, and on taking them out wrought iron globules were found throughout the mass. The vapor of benzine was next used, with a little better result. The next series of trials was made with a mixture of the vapor of benzine and steam at a pressure as before of 100 pounds to the inch. The chilling was more rapid, but the result was cast iron intermixed with the mass of ore. I then superheated the gases to a temperature supposed to be about 600° F., with a much better result, taking in 20 minutes 45 per cent. of cast iron from the converter. The charge was 200 pounds and the blow in no case exceeded 21 minutes; in one case the charge chilled in 8 minutes, and when taken out contained 31 per cent. of the weight charged of wrought iron, which, when disengaged from the cinder, appeared as white as silver. At another time a charge was blown for 10 minutes with benzine vapor admixed with steam, and then the vapor of petroleum of 28° gravity was blown in for 5 minutes; the charge appeared pasty and was allowed to chill in the converter; when it was taken out it proved to be steel, of spring temper. Being encouraged by the result of these experiments, I made arrangements to construct a more perfect plant, when I was overtaken by fire.

The result of these experiments, though not a success in economy or manipulation, exhibited so many phenomena calculated to inspire me with hope, that I firmly believe in the possibility of reducing metallic oxides by the injection into them at a high temperature of hydrogen gas, a hydrocarbon vapor, or carbonic-oxide gas, and producing thereby wrought iron, cast steel, or cast iron at will.

If the liquid process of deoxidation could be made successful, steel ingots would be made at a less cost than pig metal is now produced, as, from indications given in the experiments, not over one-half ton of fuel would be required to produce a ton of metal; no limestone being required, that expense would be saved; and the rapidity of production would make so large an output that the tonnage, cost of labor and construction, would be greatly reduced. The quality of the metal should be much better, the gaseous fuel being free from earthy matter, and the ores melted in the cupola by the use of the escaping gases from the converter.

Having made this public declaration of my belief in the future success of the direct process for the manufacture of iron, steel, and other metals by liquefying the ores, and then injecting into them at a high temperature suitable chemical agents, thus deoxidizing, refining, and carbonizing the metals as may be desired, I do so expecting adverse criticism on the point of deoxidation at high temperatures; but having observed the phenomena as indicated in the experiments made, I am willing to rest my case as stated.—*Bulletin and American Iron and Steel Association.*

Pittsburgh, Nov. 20, 1876.

PRIZES FOR INVENTORS.

III.

ECONOMIC ARTS.

WE conclude below from pages 837 and 848, Supplements Nos. 53 and 54, the details of the inventions and discoveries required, for which prizes are offered by the French Society for the Encouragement of the National Industry.

1. Prize of $200 for an industrial application of the endosmosis of liquids.

Forty years ago Du Trochet discovered the mysterious property of vegetable and animal membranes, which he termed endosmosis. The general principle may be stated as follows: When two liquids of different composition—that is to say, formed by the mixture of different substances—are separated by a membrane, certain of these substances to the exclusion of all others pass from one to the other side of the dividing septum. The membrane exercises a true elective action. Graham, the English chemist, has greatly enlarged the circle of these phenomena. We now know that membranes act only through their quality as porous bodies and not as organized bodies. Partitions of plaster, of unglazed porcelain, or of graphite, produce the same phenomena as animal and vegetable membranes. A mechanical molecular force exists which may overcome not only the affinity of a body for its solvent, but even weak chemical affinities

It is believed that this same principle may be industrially applied to concentrate matters disseminated in great masses of natural or artificial products, to eliminate dangerous ingredients, to remove the juices contained in vegetable cells, etc. Endosmosis would suffice, under certain conditions, to promote double decompositions requiring without its aid sometimes very high or very low temperatures, sometimes the influence of expensive agents or those capable of altering the useful product.

Already M. Dubrunfaut has shown in the case of molasses how easy it is to give to endosmosis an industrial and practical form. It has long been known that alcohol concentrates in membranous reservoirs which contain it. In certain tanning processes the principle has already been profitably utilized. The prize will be decreed in 1877.

2. Prize of $200 for an industrial application of the endosmosis of gases.

Graham has shown that either membranes or porous bodies in presence of gas, produce on the latter phenomena analogous to those which Du Trochet discovered in regard to liquids. Porous partitions have the faculty of diffusing the different gases with a very unequal rapidity either in *vacuo* or in a gaseous atmosphere.

The society would view with especial satisfaction some means of solving the problem due to the use of gas in apartments. In order to avoid an explosion when gas escapes, ventilators in the upper part of the apartment must be opened. But if the rooms are heated by stoves or fire-places, the draft is such as to render the efficacy of the ventilation doubtful. What is wanted is a stuff or diaphragm which will allow illuminating gas, but not air, to pass through it. Prize to be awarded in 1877.

3. Prize of $200 for preservation for at least one month, of raw meat, game or fish, by some new and easy process.

With the methods now in use, various degrees of success have been reached. Ice prevents or suspends the phenomena of putrid fermentation. A superficial coating of a weak alum solution, of carbolic acid, of creosote or essential oil of mustard, have been suggested. Also more or less prolonged contact with sulphurous acid gas, arterial injection of saline solution, the rapid cooking of the exterior of meat, etc.

All of these processes offer inconveniences, either because they are not sufficiently economical, or because the antiseptic agents leave a taste and smell disagreeable in connection with food. Any of these old methods may be entered for competition, provided that, by new dispositions, it is rendered practicable, economical, and successful in all results. The society reserves the right to grant a part of the proposed prize in cases where the complete solution of the problem not being presented, an efficacious means is communicated which shall be applicable to one or two of the alimentary substances in question. Prize to be decreed in 1879.

4. Prize of $400 for the permanent disinfection of cesspools, water closets, etc.

It is very probable that dangerous epidemics are propagated by the action which human dejecta exercise on air, water, or moist earth. What is wanted is a process, applicable in all privies, which will utilize the three following conditions:

1. Instantaneous and permanent disinfection of dejecta. 2. Destruction of all dangerous germs contained. 3. Preservation of the valuable quality of the material as manure. Prize to be awarded in 1881.

5. Prize of $200 for the rapid drying of wood by an economical industrial process, which will not alter the physical qualities of the material.

The ordinary method of seasoning wood requires a long time, and the locking up of considerable capital for extensive periods. A rapid process which will secure for the wood all the precious properties of ancient wood will be of great value. Experiments should be made on a quantity of material sufficient to guarantee the success of the method when applied on a large scale. Prize to be decreed in 1878.

6. Prize of $200 for the construction of apparatus for furnishing rapidly and economically, high temperatures for small workshops.

The invention of the Siemens furnaces and the researches of MM. Audouin and Deville on heating by mineral oils have demonstrated the possibility of easily producing the highest temperatures to meet extensive industrial requirements. It is desirable that the same principles be applied on a small scale for workshops where the casting, etc., of objects of art, necessarily small in size, is carried on. The society is of opinion that the desired result may be obtained by means now known to science. In awarding the prize the low price of the apparatus, its simplicity, and facility of working will be considered. Prizes to be awarded in 1880.

7. Prize of $200 for a new industrial application of spectral analysis.

Spectral analysis has already been applied to the study of the flame from the Bessemer crucible. The society desires to encourage other applications of this method of investigation to industrial uses. The prize will be adjudged to the application submitted, which seems most important either in results obtained or novelty of means employed. Prize to be decreed in 1879.

8. Prize of $200 for a means of preventing soot from adhering to the interior of chimneys.

When huge chimneys were in vogue it was no difficult matter for a man or a boy to descend through their entire length, scraping off all deposits therein during his progress. With the modern narrow flue, this method of cleaning is of course impossible and recourse is had to wire brushes drawn up and down in the conduit. If all soot remained in pulverulent form, this means would doubtless be efficacious; but the volatile matter from soft coal and wood is oily, and forms a concrete on the sides of the chimney, which hardens and resists the brush. It also constantly grows thicker, and finally there is formed a mass of inflammable matter, the ignition of which is extremely dangerous to the building. What is needed is something to prevent the adherence of this crust, or to hinder its formation. The prize will be awarded (in 1878), either for the above or for an easy method of effectually removing all the deposits which congregate in a chimney.

AGRICULTURE.

1. Prize of $200 for the employment for the wooding of poor and arid land, of a species of tree little utilized, and the products of which may be at least as valuable as those of forest species employed.

To multiply the number of species of forest trees capable of utilizing the worst soil to vary the products which such land is capable of yielding, will eventually tend to reclaim the land. The maritime pine now covers the dunes and the beaches of the Gulf of Gascogne. The Austrian black pine is widely scattered over the table lands of Champagne, and in Algeria the Eucalyptus yearly improves immense tracts of land. Trees of high stature, suitable for ship carpentry, or capable of furnishing resin, tan or other useful industrial products are required. The prize will be awarded in 1880.

2. Prize of $200 for the destruction of the phylloxera.

The object here is to encourage the utilization of the means discovered for destroying the vine pest in France. Of no especial interest to American agriculturists.

3. Prize of $200 for improving uncultivated land by setting out valuable fruit trees.

The idea is to find out what fruit trees will flourish and pay on uncultivated land of various kinds. Like the foregoing, this requirement is of local importance mainly, and therefore is of no particular interest here.

4. Prize of $200 for a sower of pulverized fertilizer which shall be cheap and simple.

The society says that the machines of this kind are too costly in France. Out of the scores that have been patented here we have no doubt there are many which will answer the above requirements. But patent your machines in France before taking them over.

FINE ARTS.

1. Prize of $400 for photographic improvements.

This prize is offered to the inventor of any process whereby a photographic cliché, taken from nature, and offering finely graded shades may be transformed into type capable of being printed from in the usual way. Prize to be decreed in 1880.

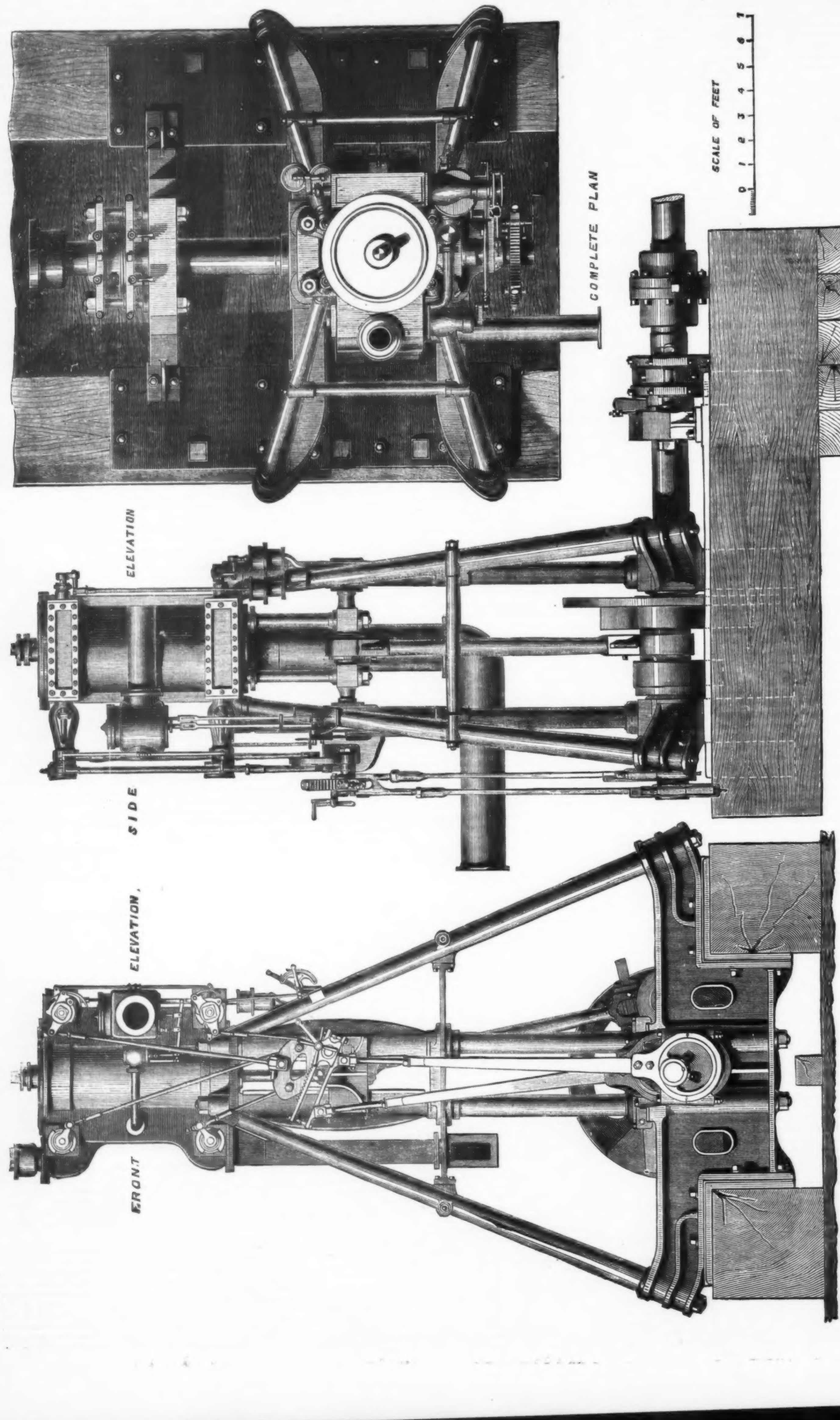
2. Prize of $400 for the exploration in France of new quarries of lithographic stone, or for the invention of any composition either metallic or otherwise which may advantageously be used as a substitute for lithographic stone.

The society believes that metallic plates may in some way be substituted for the present heavy lithographic stones, or that artificial stone may be produced from materials similar to oxychloride of zinc, magnesia, etc. Prize to be decreed in 1877.

As the devices which compete for prizes to be awarded in 1877 are required to be all submitted prior to January 1st of this year, it will be seen that the time for competition as regards them has already passed. We publish abstracts of the requirements, however, as it is not yet known whether any inventions have been submitted in answer thereto. If any devices have been presented we shall lay their main features before our readers, when the comparison of the requirements and the plans proposed to meet them will prove an interesting study.

The total number of prizes including medals offered is fifty-two. In describing them we have omitted only those offered for discoveries of purely local interest. The aggregate amount of money to be distributed is $21,300. The secretaries of the society who are to be addressed are MM. E. Peligot and Ch. Laboulaye, 44 Rue de Rennes, Paris, France.

AIR HOLES IN CASTINGS.—Bessemer showed, some eight or ten years ago, that air holes in cast steel are due to carbonic oxide originated in the liquid steel by an intermolecular reaction between the carbon of the metal and the ferric oxide formed during casting. If the metal remains liquid long enough, the gases escape; but, generally speaking, the melting point of steel is but little higher than that of its solidification. The carbonic oxide thus remains imprisoned, and gives rise to air holes, or silvery looking cells, arranged symmetrically and perpendicularly to the greater axis of the ingot.



ENGINES OF THE AMERICAN STEAMSHIP VERA CRUZ.

ENGINE OF THE STEAMER VERA CRUZ.

THE steamship City of Vera Cruz belongs to the New York and Mexican Mail Steamship Company. She is a wooden ship, and this fact accounts for the rather remarkable form taken by the engine's bed plate. The engine has a single cylinder, 4 ft. diameter, the stroke of the piston being 6 ft. Both the vertical and diagonal supports of the frame are of cast iron, with a wrought iron bolt through each. Wrought iron journals or rings are shrunk on the bottoms of the vertical columns. These have threads cut on them, and form the main bearing bolts, a very singular device. The pumps are all worked by an auxiliary engine. The condenser is a separate casting, located between the engine and the boilers in the center of the ship. A center for a beam is fixed on top, and to the starboard side is bolted the steam cylinder of the auxiliary engine, while all the pumps are on the port side. The beam extends across the top of the condenser. The feed-water from the hot well is passed through a cast iron filter 10 ft. long, 6 ft. wide, and 3½ ft. deep, the feed entering at one end and discharging at the other. There are five wooden frames fixed across the filter. Heavy woollen felt blankets are nailed to these frames, protected by a wire netting at each side from the coke with which the filter is filled up. The valve gear was designed by Mr. George Reynolds, of New York, is of the Corliss type, and to judge by the diagram—which is the reproduction, precisely half size, of an actual diagram—it works very well. The drawings so far explain themselves, that further description is, we think, unnecessary.

BOILERS OF THE VERA CRUZ.

The boilers, two in number, are of a very unusual type. The fact that they have been used for two years with perfect success is fresh testimony to the value of the vertical system. They were designed by Mr. Peek, and constructed by Messrs. Quintard and Murphy. Each boiler is 21 ft. 3 in. high, and 13 ft. 1½ in. in diameter. In it are six furnaces, giving a great area of 89 square feet. There are in each 472 tubes, 2½ in. diameter; eighty of these are stay tubes, 3¼ in. stroke. The wetted surface of these tubes is normally 8 ft. long, giving a surface of 2,285 ft., while the furnace surface is 360 feet.; the total heating surface in the two boilers is, therefore, 5,290 ft.; the total length of the tubes is 11 ft.; the furnaces are 4 ft. high, and the shell plates are ⅞ in. thick, double rivited, with butt and strap joints. The heads of the boiler are of ⅝ in plate, double riveted, with lapped joints; the stays are 6 in. apart; the tube plates are ¾ in. thick; the furnace plates are of steel, ⅜ in. thick; the central fire doors are 16 in., and the side doors, 26 in. wide. The great height of the furnaces ensures perfect combustion, and the fires run a long time without being cleaned. The pressure usually carried is 75 lbs., but the boilers are loaded to 90 lbs. The temperature in the base of the funnel does not exceed 400 degrees, and the steam is thoroughly dried and moderately superheated.

The City of Vera Cruz is 276 ft. long; 37 ft. beam; and 26 ft. deep. Her tonnage by the American standard, is 1,874; her usual consumption of hard coal is, we understand, 22 tons per day and with this the ship steams about 13 knots on 18 ft. of water.

We have here another example of the perfect success with which high steam may be expanded in a single cylinder at sea, and additional testimony to the soundness of the opinions we have expressed on marine engine construction.—*The Engineer.*

THE DURATION OF A BLOW.

THE following series of experiments, with the details of which we have been favored by Mr. Robert Sabine, will be regarded with much interest.

These experiments, which were intended as preliminary to a more extended inquiry, were made with a view to find approximately how the duration of a blow varied with the weight of the hammer, its velocity of descent, and with the materials. An iron ball, weighing ¼ lb., was suspended by a fine wire from an insulated support upon the ceiling, so that when it hung vertically it just grazed the vertical face of an ordinary blacksmith's anvil placed upon its side on a table. By raising the ball and letting it swing against the face of the anvil a blow of varying force could be struck. On rebounding, the ball was arrested whilst the excursion of the galvanometer needle was observed. By measuring the angle through which the ball was separated, its vertical fall and final velocity could be easily deduced. In this way the greatest vertical height from which the iron ball was let fall on to the face of the iron anvil was 4 ft., the least about $\frac{1}{80}$ in. Six readings were taken for each height, and they were invariably found to agree amongst each other. The means only are given in the following records:

Vertical Fall in inches.	Duration of Contact in seconds.
48	0.00008
36	0.00008
28	0.00008
17	0.00009
9¼	0.00010
4	0.00011
1	0.00013
0¼	0.00016
$0\frac{1}{16}$	0.00018
$0\frac{1}{32}$	0.00021
$0\frac{1}{80}$	0.00030

From this it would appear that when the velocity of a blow is increased, the duration is decreased within a certain limit; but that it reaches a minimum. The velocity of impact in the first experiment was about sixty times as great as in the last one; but the duration of the blow appears to be reduced only to about one-fourth of the time. The blows given by two hammers of different weights were compared. No. 1 weighed 4 oz., No. 2 weighed only 2¼ oz. The durations of the blows were as follows:

Vertical Fall.	Duration of Contact.	
	Ball No. 1.	Ball No. 2.
in.	seconds.	seconds.
1	0.000135	0.000098
4	0.000096	0.000083

It appears from this that a heavier hammer of the same material gives a longer duration of blow.

In the course or these experiments it was observed that the ball after striking the anvil rebounded irregularly, sometimes to a greater at others to a less height, and that some relation appeared to exist between the heights to which the ball rebounded and the excursions of the galvanometer needle due to the residue of the charge.

In the next series, therefore, the rebounds of the iron ball from the iron anvil were measured and recorded, from which it appeared that when the rebound was greater the duration of contact was shorter, and *vice versa.*

Vertical Fall.	Vertical Rebound.	Duration of Blow.
in.	in.	seconds.
6	2	0.000120
6	2½	0.000111
6	3¼	0.000101
6	3¾	0.000091
14½	3¼	0.000106
14½	4¼	0.000103
14½	5¼	0.000095
14½	6½	0.000086
25	7¾	0.000096
25	8¼	0.000091
25	9½	0.000086
25	12	0.000078

The explanation of this is probably that when the energy of the blow is expended in bruising or permanently altering the form of the hammer or anvil by which the contact of the two is prolonged, it has less energy left to enable it to rebound, and *vice versa.* Substituting a brass anvil and brass ball, it was found that the blow was duller, the rebound much less, and the duration contact nearly three times as great as great as when the iron ball and anvil were used.

Vertical Fall.	Vertical Rebound.	Duration of Contact.
in.	in.	seconds.
1¾	0¼	0.00036
6	1	0.00033
14½	1½	0.00026
25	2	0.00027

This series shows also the longer duration of the blow when its velocity is small. Using a brass anvil and iron ball the duration of the blow was greater than when both were of iron, but less than when both were of brass.

Vertical Fall.	Vertical Rebound.	Duration of Contact.
in.	in.	seconds.
1¾	0¼	0.00021
6	0¾	0.00018
14½	1½	0.00015
25	2	0.00014

Striking the brass anvil with a common hammer, the duration of the blow appeared shorter when struck sharply.

	Duration of Contact.
	seconds.
Moderate blow	0.00027
Harder blow	0.00019

Striking the blacksmith's anvil with a common carpenter's hammer, the duration appeared to be nearly constant:

	Duration of Contact.
	seconds.
Moderate blow	0.00011
Harder blow	0.00010

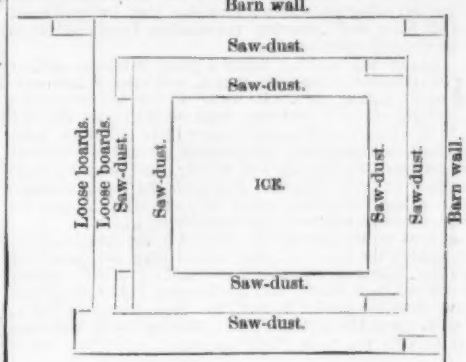
It was, of course, necessary to allow in each case the hammer to rebound freely, and not to prevent it doing so by continuing to exert any pressure at the instant of the blow. When this condition was observed, it was invariably found that the harder and sharper the blow the shorter was its duration. It was also noticed that whenever the anvil gave out a sharp ringing sound, the duration of the blow was much shorter than when the sound was dull.

A very slight error would be introduced by reason of thermo-currents set up between the metals at the moment of the blow. By reversing the direction of charge of the accumulator, however, the effect from this cause was found to be quite inappreciable. Mr. Sabine's experiments are, as we have said, altogether very interesting, and we hope hereafter to be able to record the results of his further researches.—*Engineering.*

ICE AND ICE-HOUSES.

A STORE of ice is now considered as an absolute necessity for the dairy, and it is certainly very acceptable for the household. Every person who lives "in the country," with very few exceptions, may have a supply of ice if he wishes it. The first thing to be secured is the ice; the ice-house is really the simplest affair possible. Upon every farm where there is a stream an ice pound may be made with little trouble and at small expense. To dam up the water and make a shallow pond is easy enough. To do this, drive a few stout stakes or posts on the line of the proposed dam, carefully leveling their tops by stretching a cord from end to end of the row and applying a spirit level to the line. Then nail boards to the posts in the manner of a tight fence, placing the lowest edge close to the ground. It would be better first to plough a furrow, and set the post in it, nailing the lowest board closely down to the earth; then plough furrows toward the boards on the inside, or the pond side, packing the earth down closely, and continue this until no more can be ploughed, when the earth loosened by the plough may be thrown into the dam with the shovel. A week's work will make a dam large enough to raise a large pond. When this is done, planks should be placed against the posts that have been driven in the edges of the stream, and on the pond side, so that the pressure of the water will hold them against the posts. This will raise the water which should flow over the upper plank and not over the dam when the pond is full. Every ten feet square, or 100 square feet of surface, when frozen six inches thick, will yield a ton and a quarter of ice. A pond 100 feet long and fifty feet wide, frozen six inches thick, will yield over sixty tons of ice, or enough for ten families, each having a dairy. Six tons of ice, allowing half to waste (which should not be allowed), would furnish fifty pounds a day for four months. This would supply one of the Hardin milk refrigerators large enough for a dozen cows. By selling the surplus ice to neighbors, the cost of the pond would be repaid the first year. One dollar a ton would be a moderate charge for the ice; the purchaser to cut it for himself. Forty cubic feet may be given for a ton.

To make the ice-house, the following plan will answer as well as the most costly one: Take a corner of a barn or outbuilding on the north side and mark out a space one foot from the wall on each side, seven feet square, to hold five tons of ice, or ten feet square if ten to twelve tons are required. Tack or "toe-nail" at each corner a piece of scantling eight feet long, and nail to them some rough boards so as to inclose the space marked out on the three sides. Leave the fourth side, which would be toward the inside of the barn, open. Fix scantlings outside of the space, and one foot from it, toward the inside of the barn, to support an outside wall, as shown in the diagram below.



It will be seen that upon one side the boards are left loose. This is done that the ice can be packed, and as it is packed these boards are placed one by one as the pile rises, and as the ice is taken out they are taken away one by one. A supply of saw-dust is then to be procured. Tan-bark, oat-chaff, wheat-chaff, or cut-straw may be substituted; their value being in the order in which they are named. When the ice is ready, and the place prepared, six inches of saw-dust is laid smoothly upon the bottom of the inner space, and some smooth-edged boards are laid upon it beneath where the ice is to be piled. This is to exclude air from beneath as much as possible, yet to keep the floor dry. When a foot of saw-dust is laid upon the floor, and the ice cut in square pieces of even size, so as to pack solidly, it is piled in the center, leaving a foot of space between it and the inner wall. As the pile increases in height the saw-dust is thrown in both spaces and trampled down closely, the loose boards being put in place as needed. When the pile is seven or eight feet high, or high enough, the whole is covered with a foot and a half of saw-dust. The top one of each set of loose boards is nailed firmly to the posts to keep the walls from spreading; this should be done at the commencement. It is not necessary to do anything further, as ice may be kept very well in this way without any more protection than adding covering to the top, if necessary. It would be a safe precaution to block up the floor timbers of the barn beneath the ice, to support the weight. To make any sort of ice-house, the plan here outlined may be adopted. It must be borne in mind that the floor beneath the ice must be air-tight, and yet thoroughly drained; that the walls must be double, and perfectly free from any currents of air; that the ice must be surrounded on all sides with a porous dry substance, and one as perfectly impermeable to air as possible; that the top covering should be at least eighteen inches thick, and need not be tightly closed in, but must be protected from the sun, and that the ice must be packed closely and solidly, and in freezing weather. If these requirements are observed, the ice-house may be anywhere, or of any material, size, or shape whatever. We hope that those of our readers who intend to put away ice, or expect to, or may by any probability do so, will cut out or preserve these directions, and not ask for them to be repeated.—*New York Times.*

TOBACCO PACKING.

A COMMON practice among many tobacco growers is to strip off the wrappers and binders, and use good ground leaves for tying them up in large hands or bundles previous to packing down in boxes or putting into hakes. This plan is open to many objections; the fillers are dropped out while stripping, the leaves used for this purpose as bands are apt to crumble to pieces from the drying of the butts, and in untying occasioning serious loss, which waste is also increased when the sorter whips the butts of the hand or bundle to cause separation. Again, the butts or ends of the stems are quite apt to carry more or less moisture, which it is necessary to cure off before the hand is tied up. A better method is, when the tobacco is properly assorted, tie from twelve to fourteen leaves of similar size in a hand, using a top leaf as a band, putting such top leaves as are not used for this purpose with the binders, or using them for tying up the binders; in no case should a nice ground leaf be used for tying. Top leaves are thick and heavy, wholly unfit for wrappers, but moderately used as bands for good wrappers, will pass and be weighed together, answering all purposes, as well as the sacrificing good leaves for tying. If a thick, black, inferior or worthless top leaf can be found in a hand, it is sure to be the very one the shrewd buyer will select and examine carefully, and if he tries a smoker, he will, of course, choose that very leaf, using its black burning as an argument for low prices, the producer by this time concluding he has made a mistake in packing.

In packing tobacco a space of nearly an inch should be left between the butts and the end of the case, which ends must be provided with suitable open spaces; otherwise, if packed close in boxes nearly tight, the tobacco will frequently be injured. Some growers think their tobacco so long that they cannot give up any space for ventilation, and also dislike to fill up the center of the case by reason of the hands lapping by too far. This is a mistake, for if the center of the case is pressed down hard it will ensure a better sweat and a more uniform coloring of the leaf over its entire length. When it is borne in mind that the choicest wrappers are obtained from the tip of the leaf the importance of sufficient pressure to secure the desired sweat will be still more apparent. Cases should, ordinarily, contain at least four hundred pounds; in packing, the tobacco should be kept level in the case and the hands kept as compact as possible, never laying them in the case in the shape of a fan. After packing, the cases should be piled on their sides to secure a better sweat and to facilitate future sampling. As all samples must be taken from the case itself before selling in the New York market, it is important that the tobacco should sweat on the side, so that it may come out from the case more readily. The tobacco must be in proper condition before packing in cases; if too dry it will never sweat enough and will prove bitter and acrid; if too moist it will over-sweat and become too tender; yet, next to being in just the right condition, a trifle too much moisture is preferable to a deficiency; for if the tobacco has a good body, it will throw off a large amount of surplus moisture, and will not thereby be injured.—*American Cultivator.*

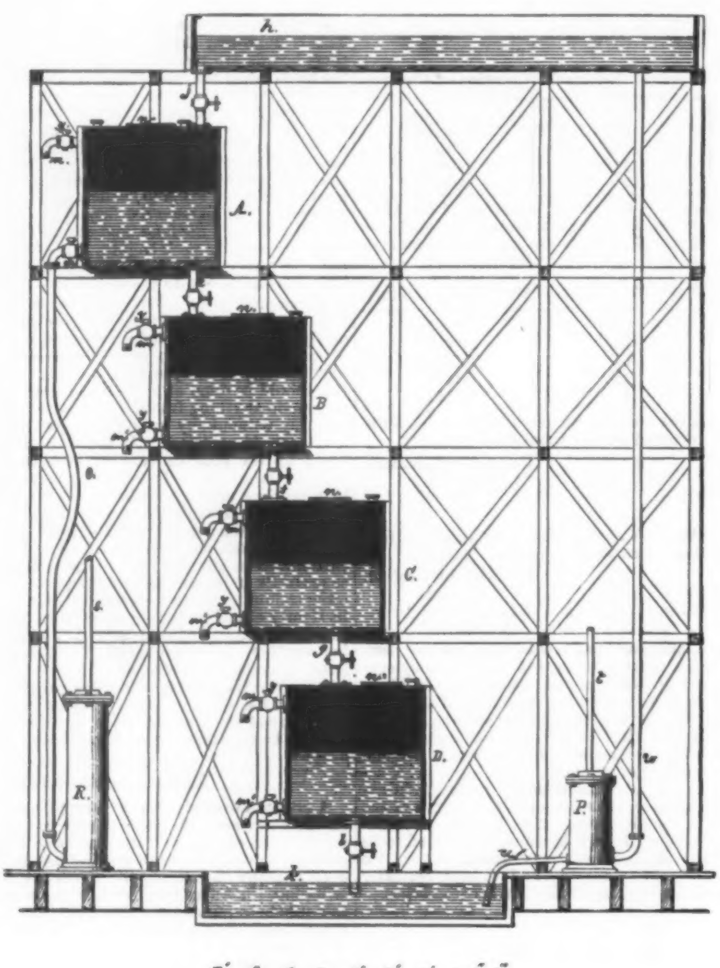
NEW TANNING PROCESS.

By JAMES J. JOHNSTON, Columbiana, O.

I IMMERSE the hides in a solution consisting of water and tannic acid, heated to blood heat, in air-tight vats, keeping them for a part of the time *in vacuo*, and the other part of the time agitating the solution in which they are immersed by an air blast, and changing the solution from one vat to another throughout the series.

In making the tanning liquor I grind hemlock, oak, or other suitable bark containing tannin, and place it in macerating casks, adding sufficient water to extract the tannin from the ground bark, and then draw off the liquid into the tank *h*, to which may be added a very little sulphuric acid, or its chemical equivalent, the greatest amount of sulphuric acid being used for tanning sole leather, care being taken to thoroughly mix the sulphuric acid with the liquor containing the tannin. It is then heated to blood heat, through the medium of steam pipes or other suitable means.

The skins of the animals are treated in the usual manner for removing the hair, etc., after which they are spread out in the vats, filling them to about one-third ($\frac{1}{3}$) of their depths. The vats are then sealed, and the tanning liquor is allowed to flow from the tank *h* through the pipe *j* into the vat A, and from vat A through the pipe *e* into the vat B, and from vat B through the pipe *f* into the vat C, and from vat C



JOHNSTON'S IMPROVEMENT IN TANNING.

through the pipe *g* into the vat D; and when the skins or hides are covered to the depth of about twelve inches, the valves in the pipes *j*, *e*, *f*, and *g* are closed, after which the elastic pipe or hose is attached consecutively to the upper coupling pipe *m* of each vat, and the air exhausted therefrom. The valves *y* are then closed.

When the skins have remained for twelve hours in the tanning liquor *in vacuo*, the pipe or hose *o* is attached consecutively to the coupling pipe *m'* of the vats, and air is forced into the liquor in the vats for the purpose of agitating it, which agitation is kept up for about six hours. Before forcing air into the vats, the valves of the upper coupling pipes *m* should be opened. After the agitation process the air is again drawn from the vats, consecutively by the means before stated, and the skin or hides are allowed to remain at rest in the tanning liquor for another twelve hours, and thus the skins or hides are alternately at rest and agitated until the process of tanning is completed, which is accomplished in about eight or ten days.

The strength of the tanning liquor should be kept as nearly as possible to a given standard, which is accomplished by drawing off a portion of the weakened liquor from the vats, and substituting stronger instead. The liquor is drawn from the vats into the reservoir *k*, from which it is carried back into the reservoir *h*, through the medium of the pipes *u w* and pump P. After the weakened liquor is pumped from the reservoir *k* into the reservoir *h*, its strength is increased to the proper standard by adding to it strong liquor drawn from the macerating cask, and then adding the proper amount of sulphuric acid.

By arranging the vats one above the other, and connecting them by means of pipes, as described, the liquor, in the operation of being drawn off from one vat to another, will be so agitated as to be thoroughly mixed, (the stronger liquor always settling to the bottom of the vat), and this agitation will also loosen the hides one from the other.

The operation of drawing off weakened liquor and adding stronger should be done as often as once in every twelve hours.

After the skins or hides have undergone the tanning process hereinbefore described, they are manipulated and treated by the currying process, as usual.

FRENCH ACADEMY OF SCIENCES.

DECEMBER.

On Cometary Repulsion.—If the hand or the conducting body of a Geissler tube be approached toward the point where an electric current develops light, a very marked attraction is noticeable. If, however, the tube contains bromine or perchloride of tin, a repulsion takes place. The light examined by the spectroscope gives lines quite analogous to those of carbon compounds, and to those observed in the spectroscopic study of comets. The experimenters (names not given) think that this goes to prove the existence of the repulsive cometary force pointed out by M. Faye.

On the Figures formed by Rotating Superposed Liquids. By M. de la Grye.—When two liquids of different densities (water and oil, for example) are drawn into circular motion by exterior tangential forces, there occurs at the point of concentration of the oil in the center a diminution of thickness. If the layer of oil is thin, there is formed at the center a fringed opening, which sub-divides if the motion is somewhat eccentric, and finishes by presenting several perfectly circular holes. If for the upper liquid a more viscous substance than oil is employed, a solution of gutta percha in benzine for instance, the forms of the opening vary still more, and in appearance resemble the sun spots. The phenomenon is completely modified if the order of the liquids be reversed, the viscous fluid being below. It is suggested that this may explain the presence of the calm spot in the center of a cyclone, and also why torrents of rain occur towards the end of such hurricanes. If the formation of sun spots be attributed to a centrifugal force, it would consequently seem that the brilliant part of the solar envelope has more cohesion than the gases which support it and than the chromosphere.

On the Gaseous Movement in the Radiometer. By M. Salet. —The cause of the motion of the radiometer is now known. It is the mechanical reaction of a hot surface on the molecules of rarefied gas. The apparatus presented by the author clearly shows the effects of this molecular projection. The mica vanes of an ordinary radiometer are rendered motionless by being attached to the glass of the instrument. Near them is suspended a light disk of mica. When the instrument is exposed to the sun, the disk turns very rapidly, and assumes the motion of the gaseous molecules projected by the black surfaces. The motion is none other than an effect of dilatation of the ascension of the heated strata, for the disk may be placed at will above or below the vanes.

Experiment on an Immersed Radiometer. By M. de Fonnelle.—The globe of an ordinary radiometer was placed in a tin vessel, and the apparatus subjected to the rays from a luminous or calorific source. Water was then poured into the vessel, and as the level rose the movement of rotation of the radiometer diminished, and finally stopped altogether, when the water passed the summit of the globe.

Accurate Clock Work.—In order to avoid the irregularities due to variation of pressure, and consequently of density in the atmosphere, produced in fine clock work mechanism, M. Redier connects the pendulum with an aneroid barometer in such a way that when the pressure augments the pendulum is shortened, and *vice versa*.

Aerial Alluvion.—A recent shower of atmospheric dust, observed by M. Gaston Tissandier, exhibited about 10 per cent of organic matter composed of microscopic algae, such as are found among many kinds of sand, especially such as exists in the Desert of Sahara. It is believed that these organisms are wafted from the sea shore by the wind, and, being deposited in sheltered localities, eventually form true geological formations.

Hot Water, a Phylloxera Remedy.—According to M. Balbiani, the egg of the phylloxera, which resists so many chemicals, is infallibly killed by being submitted to a test of 113° Fah. As it is certain that water heated as high as 140° produces no evil effects on the vine roots, its application to the eggs seems to be a simple and easily-tested method of destroying the insect.

Antique Glass.—It is generally believed that glass in ancient times was made according to the same processes practiced at present, and that its composition has not been changed. M. Peligot states that this is not the case. Primitive glass contains hardly any lime, and it is only recently that the vitrefying properties of that earth have been definitely known. Crystal or lead glass seems not to have been known at all to ancient glass makers.

On a New Method of Vegetable Analysis. By M. Fremy.—Vegetable tissues contain several varied principles. There are, first, the cellulosic bodies. These comprise: (1.) Cellulose, which dissolves in bihydrated sulphuric acid, yielding dextrine and sugar and in the ammoniaco-cupric reagent. It constitutes cotton as well as the utricular tissue of certain fruits. (2.) Paracellulose which forms the base of the utricular tissue of roots and which does not dissolve in the cupric reagent until after having been for a long time submitted to the action of acids. (3.) Metacellulose on which the same cupric reagent never has any action and of which the tissue of mushrooms is entirely formed.

Secondly, there is vasculose, a substance which connects the cellules and fibres, and remains as residue after the sulphuric acid has acted on the vegetable tissues. M. Fremy thinks that from this body is derived wood spirit and the ulmic products. Vasculose dissolves in oxidizing acids and in potash under pressure. On this last property is based the now active industry of making paper pulp from wood or straw.

Third, cutose is the base of the cuticle. It dissolves immediately in alkaline lyes.

Fourth, there are pectose and the pectates, the best known of which is the pectate of lime, which connects the cellules of the pith of trees. Lastly, there are the nitrogenous matters and the mineral bodies which form part of all vegetable tissues. M. Fremy considers that when the properties of these clearly characterized principles become definitely known it will be easily to isolate them one from another by means of a very few reagents quite analogous to those used in mineral chemistry.

The "Frigorific."—A dispatch from M. Tellier announces the arrival of the refrigerator ship Frigorific at Pernambuco, Brazil, after a voyage of 70 days from France. The meat transported and kept cool by cold air generated by the Tellier ice machine (which works on the principle of evaporating methylated spirit), was perfectly preserved. It is proposed to load the vessel with meat at La Plata, and, if the return voyage is successfully accomplished, to establish the regular exportation of South American beef to French markets.

The New Standard Rule.—Mr. Mathey, of London, has recently delivered to the French Academy of Sciences a rule in iridiated platinum designed for the operations of the International Geodesic Commission, and which, in spite of the great difficulties attending its production, is a wonderfully perfect piece of metal work. It is 12·8 feet in length, and its density is 21·51. It is composed of 89·4 platinum, 10·16 iridium, ·1 rhodium, ·1 ruthenium, and ·6 iron.

On the Adaptation of the Above Alloy to the Manufacture of Delicate Thermometers. By M. H. St. Claire Deville.—A reserved portion of the alloy described in the foregoing paragraph, amounting to some 35 lbs., has been converted into two tubes. These are closed by spherical caps, one of which by means of a capillary tube connects with a Regnault manometric apparatus. Each tube is over 3 feet in length, and one is of about a quart in capacity The latter serves as an air thermometer, designed for the determination of boiling points under a known pressure of liquids, such as water, sulphide of carbon, ether, various hydro-carbons, sulphurous acid, ammonia, and protoxide of nitrogen. On the surface of each tube are marks placed 32 feet apart. The interval between these points measured on the tube used in the experiments, and compared with the interval between the marks on the other tube, which is imbedded in ice, allows of the exact calculation of the temperatures.

This, says M. Deville, will be the realization of a programme of experiments indicated by M. Regnault, which has already been applied to elevated temperatures, and which it will be interesting to utilize for the measure of the lowest temperatures now obtainable. All substances capable of being hardened, such as glass and steel, change in dimensions according to the weather. Others, which by variations of temperature become crystallized (like zinc) similarly alter in form. Hyaline quartz, according to M. Wild, appears exempt from this mobility of form, and consequently of density. The question now is, whether iridiated platinum will act like steel or zinc or like the quartz. This will be reserved by determining with the greatest precision possible the quantity of water at 32° Fah., which one of the tubes will contain. After all the experiments, and after having caused the temperature of the metal to vary between very extended limits, the tube will be again filled with water. Each variation of 3 milligrammes in the weight of water representing the volume of the tube will correspond to a variation of ·001 millimeter in the interval comprised between the two surface marks.

On a New Method of Studying Calorific Spectra. By M. Aymonnet.—In studying calorific spectra from a constant heat source, it is possible even with quite a large thermo pile opening to obtain approximatively the quantities of heat existing in spectral positions smaller than the opening. It suffices, if for instance the pile has a, 0.1 millimeter opening to advance it; 0.2 of a millimeter at a time and at each movement to take into account both the portion of the spectrum which it leaves and the new portion which it covers. By using this mode of experiment, the author reaches the following conclusions:

1. A source of heat giving with a single prism spectroscope a luminous continuous spectrum gives through a refracting system in flint, a spectrum sensible to the pile, presenting minima easily perceptible. 2. The minima thus noted present quite a remarkable character of periodicity. 3. These become displaced when the temperature of the source varies. 4. They change in position, breadth, and increase in number, while keeping their periodical character when there is interposed in the trajectory of the radiations from the source, a vessel filled with a liquid. 5. In this last case, the minima vary still move to position with the temperature of the source.

MEDICAL ELECTRICITY.

AT a recent meeting of the New York Medical Journal Association, Dr. E. G. Loring, President, in the chair, Dr. A. D. Rockwell read a concise paper upon "The Differential Indications for the Use of the Faradic and Galvanic Currents," in which the intimation was made that the relative value of the two currents in the treatment of disease was mainly a question of experience; sometimes one could be employed with the greatest benefit, sometimes the other; and sometimes the two could accomplish what neither could do alone.

It was to be believed that the experience of physicians would confirm this view. With regard to the use of electricity, for the relief of pain, it had been generally supposed that galvanism (*i. e.*, the electrical current direct from a galvanic battery) was most useful; whereas the truth was, that faradism (*i. e.*, the electrical current from an instrument that gives shocks) was invaluable as an agent for that purpose, and relieved in many cases in which galvanism was worse than useless. The author of the paper referred to the fact that a physical and physiological knowledge of the two currents was necessary if the medical man would use them in the most successful manner, but it was not his purpose at that time to study those, and he turned his attention to the third essential, namely, experience in their use. In general, it might be stated that the faradic current, probably by virtue of its greater mechanical effects, was tonic in its action, and that the galvanic, on account of its greater power of overcoming resistance, should be used when it was desirable to act upon the central nervous system. The latter, because of the superiority in exciting nerve irritability, was also used in the treatment of paralyzed muscles which did not respond to the faradic current.

A hasty glance was made: (1) at those conditions which demanded the faradic current; (2) at those requiring the galvanic, and (3) at those diseases, conditions, or symptoms which indicated an interchangeable use of both currents.

With regard to the first class but little was to be said, inasmuch as asthenopia was about the only distinct disease which demanded the faradic current alone. Concerning the exclusive use of galvanism, not very much more was to be said, although that current was the one more commonly employed in the treatment of spinal irritation, certain sequelæ of cerebro-spinal meningitis, and most skin diseases in which electricity had been found to be of service.

Under the third head, it had been found that paralysis was the condition in which electricity was most serviceable. In hemiplegia, when there existed an exalted electro-muscular contractility, electricity, if employed, should be in the form of faradization, with an exceedingly mild and rapidly interrupted current. In paraplegia, as a rule, galvanism alone was most serviceable. In the treatment of facial paralysis, especially when caused by cold striking against the side of the face, a much weaker current of galvanism might cause the muscles to act less than was necessary in health, and the faradic might not produce any contractions whatever. After a time, however, the muscles might respond to faradism. In true neuralgia it was said that galvanism was most beneficial; while false neuralgia would yield most certainly to faradism. In the great majority of cases in which firm pressure aggravated pain, the galvanic current was indicated; but when such firm pressure over the course of the nerve did not increase the pain, the faradic current was indicated. That was a general rule, although there are some exceptions.

For the relief of the pain of herpes zoster, the galvanic current was invaluable. The tormenting, distressing, and acute pain of mammary cancer could be relieved in a remarkable manner by the use of galvanism; and although relief, as a matter of course, was not permanent, the necessity for the use of opium could be postponed for a long time, if not entirely avoided. Faradism, in the doctor's experience, had not been beneficial under like circumstances.

For the relief of chorea, amenorrhœa, associated with anæmia and debility, nervous exhaustion, in general the faradic current was advised.

In conclusion, Dr. Rockwell alluded to the tonic effect of general faradization. He was of the opinion that it had a wider range of application than any other method by which electricity could be employed, and that a thorough study of the practical use of the principles involved in that method would amply reward the practitioner for the time and labor spent in the investigation. The power of electricity as a tonic was first advanced by Dr. Rockwell in a series of articles published in the *Record* nearly ten years ago, and it was believed that the correctness of his theory had since then been established by clinical experience.

In reply to a question, Dr. Rockwell expressed the opinion that all the beneficial effects of electricity could be better obtained through other means than electrical baths.—*Medical Record.*

EFFECTS OF CUTANEOUS IRRITATION UPON THE KIDNEYS.

BETWEEN the skin and the kidneys there undoubtedly exist relations of a peculiar kind, altogether independent of the vicarious or compensatory offices they are able to perform for each other. Wolkenstein has recently published the results of a long series of experiments designed to throw light on some aspects of this obscure subject (*Centralblatt für die mediz. Wiss.*, 1876, No. 31). The experiments were all performed on healthy rabbits. A superficial area of 25 square centimètres having been shaved, various irritants, such as oil of mustard, tincture of iodine, mercurial ointment, croton oil, solution of tartarated antimony, etc., were applied to the skin. The urine was collected and examined at frequent intervals. The application of the milder irritants was followed by slight and transient albuminuria, without any evidence of structural change in the renal tissues. When the skin was more severely irritated, the urine contained a larger proportion of albumen, together with renal epithelia and casts. Death not unfrequently occurred, preceded by convulsions, probably of uraemic origin. Microscopic examination of the kidneys showed the appearances characteristic of acute parenchymatous inflammation. This artificial nephritis was attended by a considerable elevation of temperature and increased frequency of the cardiac and respiratory movements. The urine was diminished in quantity; it contained more urea and less chlorine than in health. Of the various chemical irritants employed, one only, viz., mercurial ointment, produced no obvious change in the composition of the urine. Wolkenstein ascribes the renal disorder to two different sets of causes. The irritant may be absorbed into the blood and exert a selective action on the epithelial elements of the kidney or on the walls of the renal capillaries (as, *e.g.*, cantharides); or the fever induced by the inflammatory process in the skin may give rise to constitutional effects, of which the nephritis may be one. Neither of these hypotheses is adequate, however, to explain the results observed after faradisation of the skin. This does not give rise to permanent changes at its point of application, and cannot, of course, exert any specific action on the renal tissues. Yet it is always followed by effects like those described above. Immediately after the electric brush has been applied, for a few minutes only, to the shaved patch of skin, the temperature rises, the urine is increased in quantity, and contains a trace of albumen, an excess of urea, and a lessened proportion of chlorides. These morbid phenomena subside in a few hours. When the faradisation was continued for a longer period, the albuminuria was more severe, and lasted for thirty-six hours; though no fresh application of electricity was made during this time. The kidneys were found to be in a state of passive congestion; the ears and paws cold and cyanotic. To explain these curious results, the author has recourse to an unlikely hypothesis. He supposes that the irritation conveyed along the afferent nerves excites the vaso-motor center in the medulla oblongata, and thus causes spasm of the arterioles all over the body; the systemic blood-pressure is raised, and the increase of tension in the renal capillaries is so great as to cause transudation of albumen through their walls. The persistence of abuminura for many hours after the irritation has subsided is explained by supposing that the capillary walls undergo a structural change during the temporary stagnation of blood in their interior—a change which deprives them for some little time of their normal power of resisting the transudation of albumen. —*Academy.*

THE QUININE-FLOWER.

By J. DABNEY PALMER, M.D.

THE quinine-flower is an annual from twelve to eighteen inches high, has an erect green stem, linear leaves of about one-half to one inch in length, and small white flowers. The root consists of numerous slender fibres.

It is a native of Florida, and is found most abundantly in flat pine woods, in a moderately dry soil, making its appearance in March or April, and flowering from July to September. The specimens furnished me were gathered three or four miles south of Monticello, in Jefferson county. In the lower portions of the county it is very abundant, and is successfully employed by those living in its vicinity for the cure of different types of malarious fever, the whole plant being used, either in the form of decoction or extract, and given *ad libitum*, or until the patient feels the effects of quinine in his head. It is a curious fact that persons brought under the influence of this remedy experience similar sensations—such as tension or fullness in the head, ringing in the ears or partial deafness—as when under the influence of quinia, and hence its name. Its reputation as an antiperiodic was established during the late civil war, when, owing to the scarcity of quinine, every opportunity was offered for testing the relative value of various substitutes.

The quinine-flower is intensely and permanently bitter, yielding its properties to water and alcohol. A saturated tincture in doses of one teaspoonful every two hours was found sufficient to break the paroxysm of intermittent fever. Larger quantities, however, may be given in obstinate cases, or in the remittent form of the disease.—*American Journal of Pharmacy.*

SALICYLIC ACID.

SOME experiments were made with urine in which salicylate of sodium had been dissolved in the proportions of 1, 2, 3, 4, and 5 grains to the fluid ounce, 40 grains of sugar and half a grain of yeast were added to an ounce of each. The one grain and two grain solutions fermented rapidly, the three and four grain solutions less rapidly, and the five grain solution remained unaffected by the ferment.

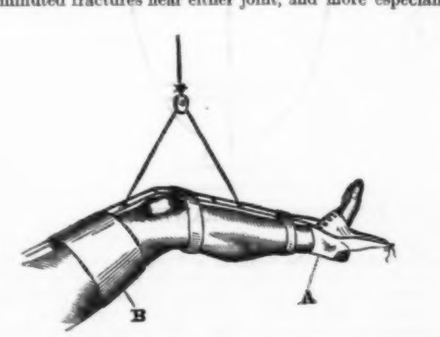
Solutions of salicylate of sodium in urine appeared to exert no retarding action on the production of oil of mustard, or oil of bitter almonds. Aqueous solutions of salicylate of sodium acted in a similar manner.

It has been stated that the salts of salicylic acid do not possess antiseptic properties, but it is evident that salicylate of sodium is capable of preventing fermentation if present in the proportion named.—*Amer. Jour. of Pharmacy.*

NEW APPARATUS FOR FRACTURES OF THE LEG.

By OSCAR J. CROSKERY, Professor of Surgery, College of Physicians and Surgeons, Baltimore, Md.

WHILE fully satisfied of the fact that no apparatus other than the starch or plaster of Paris bandage is required in the great majority of fractures of the leg, still there are certain injuries in which these applications will not suffice. In a simple fracture of both bones of the leg, with some comminution, I have applied the starch bandage, and had the patient walking on crutches on the fifth day; still, for badly comminuted fractures near either joint, and more especially



for compound comminuted fractures and for resections—in a word, wherever *extension* of some degree is required—the starch or plaster is useless. It is for the latter variety of fracture above spoken of, and preëminently for Pott's fracture, that the present instrument was devised.

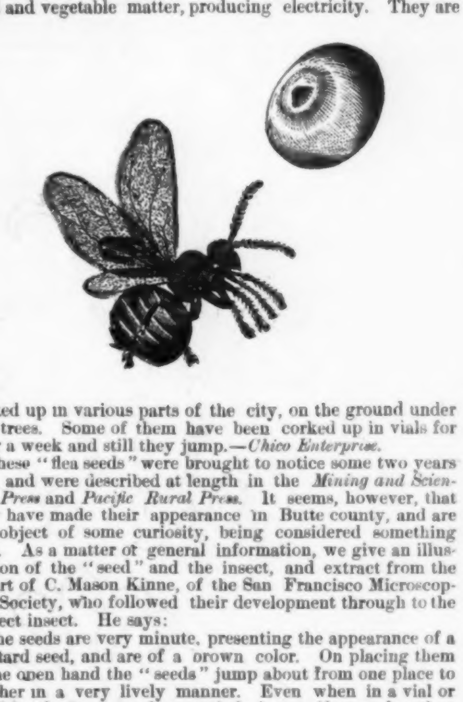
As will be seen by the accompanying wood cut, the splint consists in another adaptation of the wire, first used by Dr. N. R. Smith; but the principal upon which its acts will not permit of its application to the thigh.

The figure represents the splint as applied before the bandage, which encircles all, has been used, and may be called the *permanent* apparatus. As shown, the wires, moderately strong (Nos. 7 to 10 are the best sizes), should extend from the upper portion of the middle third of the thigh to nine inches below the sole of the foot. From about one inch above the malleoli to their upper extremity they should be parallel, three inches apart, and bent in an easy position opposite the knee. One inch above the malleoli they should commence to bulge, and a little above the sole of the foot, which should be the widest part of the splint, the separation must be from five to six inches. The wires then slope gradually to three inches in width, and are then securely fastened by a strong end piece. Along the whole course of the splint the wires are fastened together by cross pieces of wire.

The application is as follows: the splint, measured upon the sound limb, is first bent opposite the knee, and the gaiter is applied to the foot of the injured side. The injured member is then held in an easy position by an assistant, the patient's thigh being held at an angle of near 60° to the trunk, with the knee bent. The foot is then carried through the bulge between the wires, and a pieces of adhesive plaster, B, from six to eight inches wide, is made to encircle both thigh and splint. (The other two bands shown in the figure are merely suspensory.) The gaiter, A, is then attached to the end piece by means of tapes, as shown in the cut. By making traction upon the tapes passed over the end piece, and fastened when a sufficient amount of extension is gotten, the splint is then forced upward, and this movement is counteracted by the adhesive plaster on the thigh, the gaiter acting as the *extension*, the plaster as the *counter-extension*. The toes can be elevated or depressed by loosening or tightening the lacing of the gaiter at its lower portion. A common roller is then carried over all, from one end of the splint to the other. This bandage can be removed at every dressing, but the apparatus, as shown in the drawing, remains until the cure is effected, the surgeon increasing or relaxing extension as may be required.—*New York Medical Journal.*

JUMPING SEEDS.

DURING the past week considerable wonderment has been created by the appearance of small minute seeds, which keep up a continual jumping, as if possessed of life and animation. To give them a name has baffled all our doctors and scientists, and curiosity has run wild to know what they are and what makes them jump. We have thought over the matter and tried to explore the mystery, but can only arrive at the conclusion that they are parasites that grow on the oak leaf, and when ripe fall to the ground. The life which is exhibited is, perhaps, derived from a combination of animal and vegetable matter, producing electricity. They are



picked up in various parts of the city, on the ground under oak trees. Some of them have been corked up in vials for over a week and still they jump.—*Chico Enterprise.*

These "flea seeds" were brought to notice some two years ago, and were described at length in the *Mining and Scientific Press* and *Pacific Rural Press*. It seems, however, that they have made their appearance in Butte county, and are the object of some curiosity, being considered something new. As a matter of general information, we give an illustration of the "seed" and the insect, and extract from the report of C. Mason Kinne, of the San Francisco Microscopical Society, who followed their development through to the perfect insect. He says:

The seeds are very minute, presenting the appearance of a mustard seed, and are of a brown color. On placing them in the open hand the "seeds" jump about from one place to another in a very lively manner. Even when in a vial or small bottle the same characteristic is manifest, and as they were somewhat peculiar, the "flea seeds" have attracted considerable attention.

The gall or cocoon is found lightly attached to the leaf of the oak, and in time falls to the ground, when the noise occasioned by the thousands leaping about, without any apparent cause or organs of motion, sounds very much like the falling of fine rain on the leaves. An examination shows that the extraordinary activity displayed is caused by the spasmodic contraction and concussion of the abdominal parts of the occupant against the side of the shell, which movement does not cease even after the covering is nearly split in halves, if the tender structure of the chrysalis be not injured. That it is the chrysalis and not the larvæ has been shown by the microscope, and its change to the perfect insect has been noted at weekly stages.

The average length of the insect is five-hundredths of an inch, and in each has been found from 60 to 80 pear-shaped ova. The engraving gives its general appearance, with wings raised somewhat unnaturally, for the purpose of showing their size and shape. It was drawn on the wood, from the microscope, by Mr. Kinne, and is enlarged 20 diameters. Its ovipositor is a tiny, though perfect, piece of Nature's mechanism, and lies encased in a sheath at the lower part of the abdomen. Mr. Henry Edwards, of the Microscopical Society, furnished the following technical description of the curiosity:

GENUS CYNIPS—*L. Cynips Saltatorius* (nov. sp.)

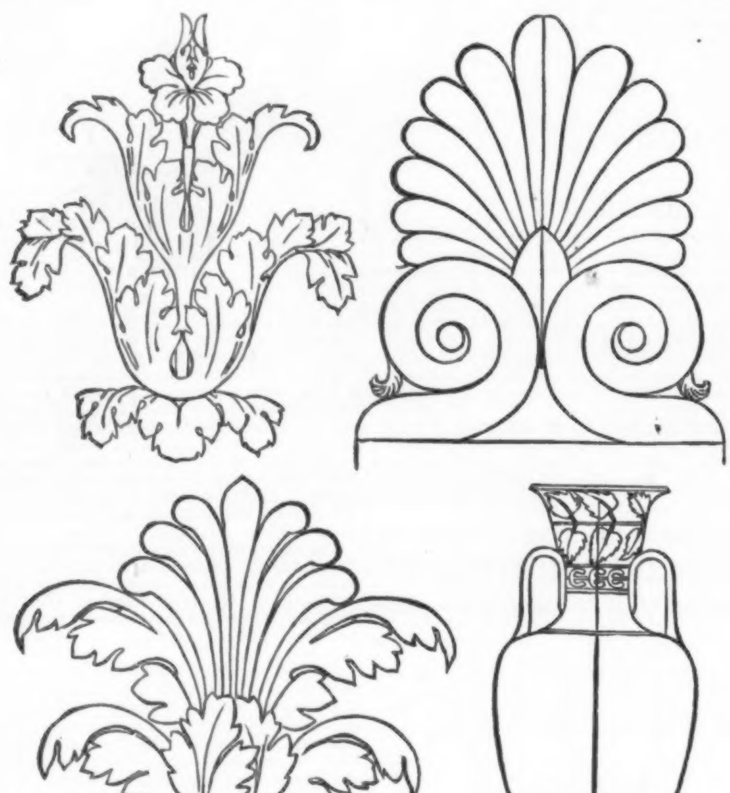
Black, shining. Head broad between the eyes, which are very prominent. Antennæ 14 jointed, the first and second joints being much swollen, and the third joint larger than the other two; the remaining joints are long, simple and nearly equal. Thorax densely but finely punctured, very globose in front, projecting so far as to almost hide the head. Abdomen globose, shining. Ovipositor cases, short, spatulate received into marginal groove in the body. Ovipositor itself flesh color, curved inwardly towards its middle. The abdomen is six jointed. Terminal joints of palpi, hatchet shaped. Tarsi very hairy throughout, the anterior pair with six and the remainder with seven joints. Coxæ very globose. Tibæ long, with large and powerful spines at the base.—*Mining and Scientific Press.*

BRITISH PRIZES FOR DRAWING.

As a means of stimulating a branch of industry specially available for the employment of educated females, the Lords of the Committee of Council on Education, offer prizes for fans painted by female students in any school of art connected with the Science and Art Department, viz.: One prize of £5, two prizes of £3 each, £6; three prizes of £2 each, £6; five prizes of £1 each, £5. The decoration is limited to foliage or flowers, or these conjoined, with landscape vignettes.

WHITWORTH SCHOLARSHIPS.

With regard to the Whitworth Scholarships, it may be useful if we say that competitors in the schools and night classes for the Whitworth £100 Scholarships are required to produce a certificate of having passed in the ability to draw outlines like the annexed, either enlarged or reduced in size from a copy. The examinations are held at any school of art or night class in the United Kingdom, usually during the month of May, or, if specially required, in a science school.—*Engineering and Building Times.*



THE WHITWORTH SCHOLARSHIP REQUIREMENTS FOR DRAWING.

ANCIENT TREASURES IN GREECE.

DR. SCHLIEMANN continues his labors in Greece under a lucky star, and the researches which he is so ardently making are signally crowned with success. The discoveries at Mycenæ are truly great, and tend largely to further our knowledge of the Ancients. The progress of his excavations led him up to the ancient tombs on the Acropolis, and in the great circle of parallel slabs beneath the Archaic sepulchral stones, considered by Pausanias, following tradition, as the tombs of Atreus, Agamemnon, Cassandra, and Eurymedon, an immense quantity of jewelry presented itself to the astonished eyes of Dr. Schliemann. It is impossible at a first glance to describe the rich variety of the treasure, and before we present to our readers the very interesting account of the celebrated discoverer, we shall sum up as near as possible the details of the jewelry. In a portion of a tomb, human bones, male and female, were found, together with plate, jewelry of pure Archaic gold, weighing 5 kilogrammes, two sceptres with heads, crystal and chased objects in silver and bronze. Immediately after commencing excavations at an adjoining tomb, a large head of a cow in silver with immense horns of pure gold was found, and not far from it a large girdle of gold, five gold vases, an immense number of golden buttons, numerous swords of bronze, all marvellously worked, but no trace of iron work. In the last tomb there were also a breast-plate, mask, and baldric, all of gold. The masks seem to be the portraits of the deceased. Further, a helmet, two diadems, a woman's large comb, six vases, two bracelets, two rings, three brooches, leaves, and other objects of similar nature. Neither were axes, warriors knives, and arrows wanting; of the latter twenty-five were found with flint heads.

The following extracts from letters of Dr. Schliemann, dated Mycenæ, November, 1876, are of interest:

"I found below the three sculptured tombstones, of which I sent you the drawings, a square tomb 26½ feet long and 11¾ feet broad. The depth of it I cannot yet determine, as it has not been entirely emptied. It certainly exceeds 14½ feet below the surface of the rock and 53 feet below the surface of the Acropolis, as it was when I began my excavations there. The tomb borders on the wall which supports the double circular parallel rows of tombstones: nay, the wall goes through the N. W. angle of the tomb. This fixes their relative age. When that wall was being built, the old tomb was evidently emptied, and I found in it only thirteen gold buttons (one of them as large as a five franc piece), with splendidly engraved spiral lines, and with the sign which some archæologists call the Svastika or Arani, from its similarity with the Indian symbols of that name. There was a mass of gold blades with impressed circles or spiral ornaments, but nothing *in situ*, and scattered about at intervals of 3 feet and 6 feet.

"In the second row of sculptured tombstones I found beneath two slabs a square ditch 11¾ feet broad, 21 feet long, and cut 14½ feet deep into the rock. Its bottom reaches, therefore, to 30 feet below the surface of the mount. Around the four sides of the tomb is a Cyclopean wall 5 feet high and 2 feet thick. It contained bodies reposing on the rock. They had evidently been burnt, the bones were embedded in black ashes and covered with a layer of large stones. It is impossible as yet to determine the number of bodies contained in this tomb. The bones of one person dug up at the south corner were covered with five immense gold leaves—the first leaf, 47 centimetres long and 10 broad; the second, 47½ centimetres long and 6½ broad; the third, 55 centimetres long and 6½ broad; the fourth, 63 centimetres long and 6½ broad; and the fifth, 63 centimetres long and 6½ broad. Upon these gold leaves were found five crosses, each 18 centimetres long and 4 centimetres broad, and formed each of four gold leaves. There were, besides, four gold blades of circular form—one 8, the other 5½, and the third 2½ centimetres in diameter—and numerous ornaments which I cannot here describe.

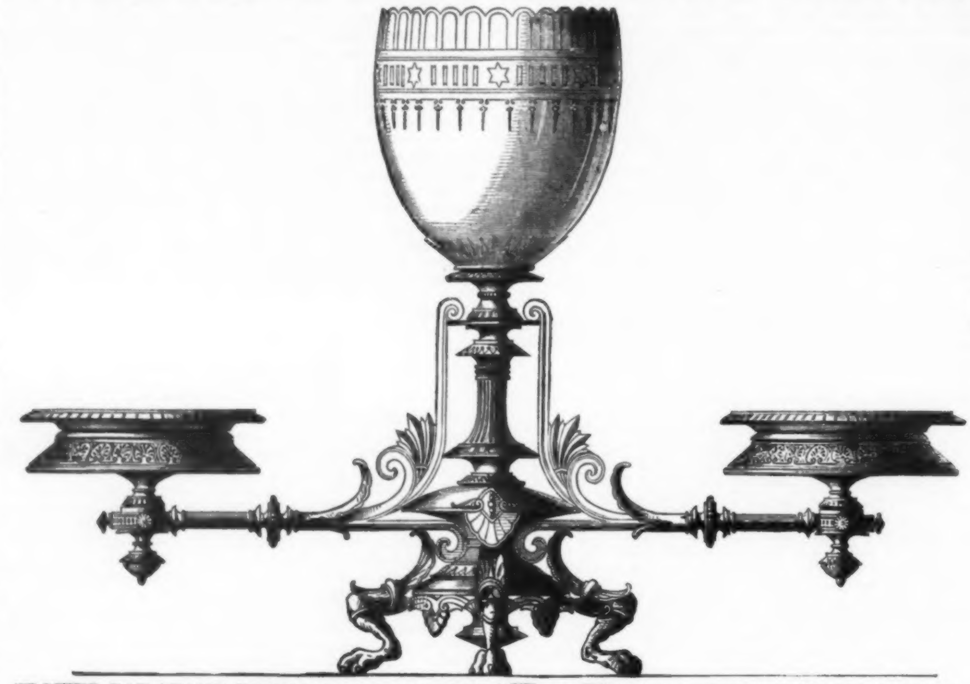
"I have now begun to dig up the tomb beneath the stone with the bas-relief of the two serpents, and another beneath two unsculptured stones in the second row. There are more such tombs in the large circle of the double parallel row. I shall not leave Mycenæ till I have examined them all.

"As the wall with the circular rows of slabs passes through part of the first tomb, and as the second tomb, which was undisturbed, contains only more ancient hand-made pottery, it seems clear that these tombs are far more ancient than the double parallel rows of slabs, which were probably erected in honor of the heroes who, as tradition has it, lay buried in those immense square tombs.

"The Treasury has given me immense trouble, and though I have been working at it for more than two months, with a large number of laborers and carts, it is still far from being entirely cleared out. The center of it is clear down to the virgin soil, and likewise the threshold. Nothing of particular interest has as yet been found there."

One day later Dr. Schliemann writes:

"I hasten to inform you that in the same tomb were found the calcined remains of two more bodies, each with precisely the same number of gold leaves, round blades, and crosses. All these objects have the same beautiful ornamentation of spiral lines and circles. In a day or two I shall know how many more tombs there are. I am now clearing the whole circle down to the rock."



FLOWER POT STAND IN BRONZE, WITH FISH BOWL, ¼ FULL SIZE. DESIGN OF GIRARD AND REHLENDER. MADE BY W. MÖLDNER, VIENNA. (*From The Workshop.*)

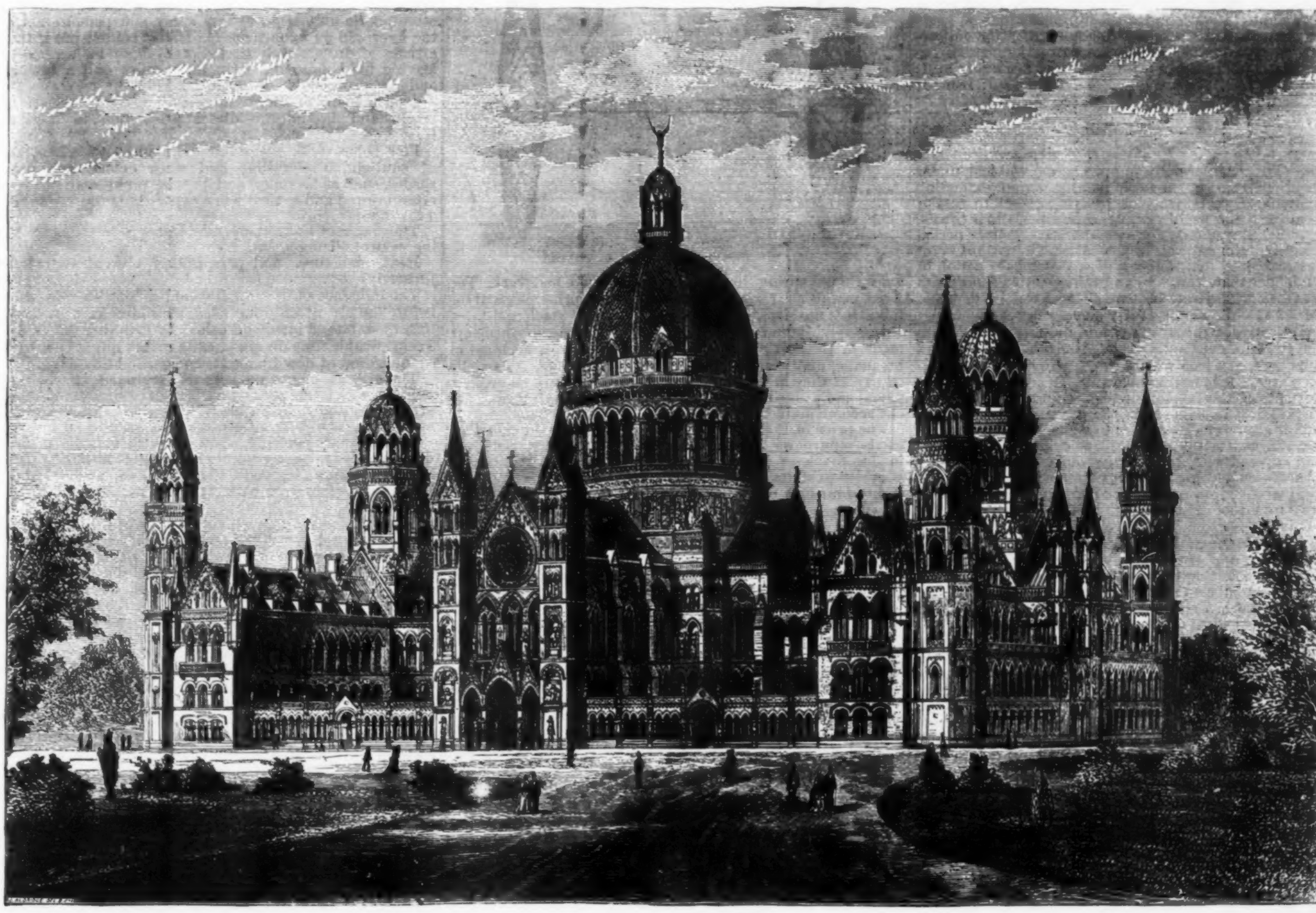
DEVELOPMENT OF ART.

THE Bishop of Carlisle lately attended the annual meeting of Carlisle, Eng., School of Art, and made a speech upon art. He said there was a great tendency in this age for people to be proud. We had done many things that our ancestors had not done before us. We had railways, the telegraph, all the machinery of modern life and progress was remarkable, and our discoveries in chemistry had been so very wonderful that we were apt to think that our forefathers were very great fools, and that we were exceedingly wise. If there was one thing which more than another tended to show us that we were not much better than those who had gone before us, it was art. If we wanted anything good in art, we must almost, if not quite, without exception, go back to antiquity, and set ourselves against the present. One great reason why we did not now rise to the height of art to which men did rise in those days was, that there was a want of concentration of purpose on one special object. Men's minds were so much diverted and divided. The law of the division of labor might be applied to manufactures, but it would not do with regard to art. The man who wished to attain excellence in art in any line must give himself to that line only—must concentrate his attention upon one small point. Another thing tending to interfere with the perfection of art was the wealth of the age. What was done in one place was sure to be done in another, and it was impossible for an artist, whether painter, sculptor, or architect, to follow his own genius and have his own way. If a man painted a picture which was a success in an exhibition, the result was that every rich man wanted to have a picture just like that. That led to the reproduction or manufacture of pictures, and not the progress of true art. This tendency to interfere with the development of art, and to make us inferior to those who had gone before us, was due more to the condition of our own times than to the inferiority of our own brains. There was a good deal in the movements of the present day with regard to trade which tended to interfere with what might be called the lower department of art—that was, the tendency of the present generation to get as much money as possible for as little work as possible. That kind of spirit was embodied in trades' unions, which prevented a man of ability doing his utmost because other men could not do as much as he could, and there was some rule of the trade preventing a man of power and genius exerting himself to the fullest extent. The real way to succeed, whether in trade, art, or manufacture, was for a man to have a thorough pride in what he was doing, to be determined that that which he turned out of his hand should be the best he could turn out, and not to care whether he was overpaid or underpaid.

REMOVAL OF INK STAINS.—Grimm, in the *Polytechnisches Notizblatt*, proposes the following method for removing indelible ink and other silver stains without the use of cyanide of potassium. Chloride of copper is first applied to the tissue; it is next washed with hyposulphite of soda solution, and afterwards with water. It is said that this may be employed on colored woven cotton tissues. For white cottons and linens, dilute solutions of permanganate of potash and hydrochloric acid, followed by the hyposulphite of soda and clear water, is preferable. For cleaning the hands, iodine dissolved either with iodide of potassium or in alcohol is used, following by aqua ammonia.

G. G. SCOTT'S PLAN FOR THE GERMAN PARLIAMENT BUILDING.

In the year 1872, the architects of the world were invited to compete for a prize to be awarded for the best plans for a German parliament building at Berlin. Of the foreign architects who competed, only one was successful. It was the renowned English architect, Sir Gilbert G. Scott, who had prepared the plans jointly with his son, John O. Scott. Next to the plans of Mr. Bohnstedt, to whom the first prize was awarded, the design of Mr. Scott created at the public exhibition in Berlin, the greatest interest with his colleagues as well as the lay public. The English architect has looked upon the question from a different point than his German colleague. While the latter has mainly made use of the forms of the ancient Roman style, so as to admit of the largest extent of plastic ornamentation, the former has made an attempt to develop the Germanic style, from the high point which the same had reached in the 12th and 13th centuries, and adapt it to the practical wants of the present time. Sir Scott himself states, that the Germans were in the beginning of the 13th century on the point to create a form of gothic architecture peculiar to them, but that the fruition of this tendency to form a separate style, was modified, and at last interrupted by the then prevailing influence of the French style. The British architect assumed that this interruption had never occurred, and made the characteristic features of the pure gothic style, as found in the monumental buildings of the times of Frederic Barbarossa, the basis of his designs for the building that should become one of the finest buildings of the new imperial city. For the purpose of imparting to this undeveloped gothic style a greater freedom and perfection, Scott attempted a combination of the gothic style with the dome style, as expressed in the highest degree of perfection in the cathedrals of Florence and St. Peter's in Rome. According to his opinion, there is no form more proper and better adapted for a monumental building of national importance than the dome style as brought to so admirable a degree of excellence in the master-work of Michel Angelo, at Rome. The dome would surmount and cap the other parts, and furnish at the interior a large hall for the sessions of the Parliament. In some of the details of the dome, the British deviated from his original models, as, for instance, by separating the inner from the outer cupola. The "lantern" which crowns the whole, is placed on supporting parts that are introduced between these cupolas. The invention of this construction has been commonly ascribed to Sir Christopher Wren, who used the same in the church of St. Paul, in London, and who had in this respect a large number of imitators. But this system had already, centuries before, been applied in the church of St. Marcus, in Venice, only in different material. It may be remarked that none of the plans, successful in the first competition, have been accepted for final execution.



SCOTT'S DESIGN FOR THE GERMAN PARLIAMENT BUILDING, BERLIN.

THE HOLBORN VIADUCT HOTEL, LONDON.

The Holborn Viaduct Hotel and Station, now just completed from the designs and under the superintendence of Mr. L. H. Isaacs, 3 Verulam Buildings, Gray's Inn, occupies a site 235 ft. long by a depth of 70 ft., while in the important element of height it towers above its neighbors both on the right and left. The facade is composed of a central block of 13 bays, between two slightly projecting pavilions of three bays each; these are again flanked by wings—that on the eastern side containing the principal entrance to the hotel, and that on the west the exit from the station in rear. The whole of this façade is executed in Portland stone. Mr. Mills, engineer to L. C. & D. Railway, determined upon covering the station with a ridge and furrow roof, the greatest height of which is some 24 ft. This decision has proved an immense gain to the interior of the hotel, for it may be safely asserted that there is not a dark corner throughout the Viaduct Hotel. While speaking of the engineer's share in the design of the works, it may be stated that to him must be accorded the credit of laying in the foundation of the hotel over the low level railway, consisting of three enormous girders to receive the front, middle, and back walls, as were also the planning of the station proper and all its adjuncts left to his charge. The first contract embraced the excavation for the main building (which, owing to the raising of the Viaduct, had to go down some 30 or 40 ft. below the ground in order to reach the blue clay), the basement, the sub-basement, and the booking offices and restaurant on the ground floor. The hotel proper formed the subject of a subsequent contract. The ground floor is on a level with the Viaduct, and also with the platforms, and is principally devoted to the purposes of the railway, including a large and lofty-looking office, together with waiting-rooms, ladies'-rooms, and the usual conveniences. At the east end of the ground-floor is the restaurant and buffet, 70 ft. long, 30 ft. wide, and 20 ft. high. The booking offices are approached by vehicles under a covered way or loggia, running parallel with the Viaduct, and having entrances at either end. This loggia extends nearly the whole length of the ground floor. Access to the hotel is obtained both from the Viaduct and the platforms in rear. The Viaduct enterance conducts to the hall and grand staircase, the latter being 20 ft. wide, and lighted both from the top and sides. The first-floor contains several sitting-rooms, besides large coffee rooms, reading rooms, billiard rooms (public and private), and smoking-room. The principal coffee room is 65 ft. long and 36 feet wide, extending in height through the first and second stories about 30 ft. The ceiling and walls of this room are highly enriched, and are now in the hands of the decorator, Mr. J. Crossley, of Newark, Notts. Members of the confraternity of Freemasonry will be interested to know that on the second floor a suite of rooms has been specially designed for the purposes of the craft. These rooms have a southern aspect so that they will be free from the noise of the street traffic, and from the possibility of being overlooked. The bed-rooms are 170 in number, and are placed on the second, third, fourth, and fifth floors, each floor having its own distinct "service." The sixth, or top floor, is designed for the service of the hotel. The kitchen, with the necessary adjuncts, is located on this floor, as well as the servants' bedrooms, a powerful lift being employed to raise the coals and comestibles to this level. This arrangement not only insures abundance of light and air, but renders the rest of the building free from the odors which would pervade it, were the kitchen placed in the basement or on the ground floor. Bath rooms, closets, and lavatories are placed on each floor, and passengers who may be unwilling to mount the staircase are accommodated with a lift specially provided for their use. It should also be added that the corridors on each floor are of iron and concrete fireproof construction. An interesting point in connection with the building, which did not fail to strike passers-by while it was being erected, is the fact that it was constructed without the aid of the scaffolding usually employed. The authorities objected to the requisite hoarding, declining to allow the pavement to be obstructed for so long a period as that required for the erection of the building. Mr. Webster, the contractor, therefore, designed and constructed two steam cranes with long arms, the larger one of the two being capable of, and actually accomplishing the twisting of, the chimney terminals, and bedding them in the exact position required. These steam cranes travelled on iron rails laid down on a platform level with the first floor, the public footpaths being maintained under the platform. It is believed that this is the first time that this mode of construction has been adopted in London. The total outlay involved has been, in round figures, £120,000. The hotel has been leased to Messrs. Spiers and Pond, and will be opened for the use of the public almost immediately.—*Building News.*

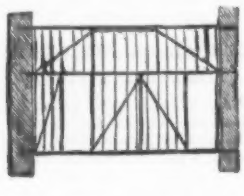
ARCHITECTURAL SCIENCE.—CARPENTRY.

ELEMENTARY REPLIES.

QUESTION.—*Describe the chief joints used in carpentry, and the objects to be attained.*—The kind of joint in most frequent and general use is the mortise and tenon joint. The mortise is a sinking of gauged parallel width, formed by a mortise chisel, in one piece of timber, the piece to be inserted into it having one or both sides cut away, leaving a projecting piece gauged to the same thickness and of the same size as the mortise, called the tenon, the length of which is regulated by the depth of the mortise, and starting from a shoulder or abutment on one or both sides, forming the line of contact, and may be made to enter the mortise at any angle of inclination. There are various forms of this joint, but the object in all is the same—that the pieces may be prevented from sliding on one another in any direction, and to obtain the greatest possible strength at the joint, in the neatest possible way. The shoulders of the tenon are of the chief importance in resisting thrust or compression of the framing. Tenons inserted at oblique angles are truncated by cutting off the acute angle square from the shoulder, and the mortise checks are frequently notched or joggled, the shoulders having similar projections given them to fit the same. When two or more pieces of timber have to be joined lengthways scarfing or fishing must be resorted to. Where the same section must be kept throughout, and the faces all in line, scarfing is the proper method. This varies from the simple halving to the more complicated single or double-notched, splayed, and keyed joint; but in all, the ends of both pieces are cut to the same template, so arranged that when fitted together the indents and projections shall correspond, and a space is left open between the central shoulders or abutments, forming a mortise, into which is driven a pair of folding wedges or keys, forcing the pieces up to the outer shoulders, and holding them firmly together. Where suspended and exposed to transverse strain, bolts and plates are added. Fishing is a very strong form of joint where the appearance is not an object. In this the two timbers are made to abut at the ends, and on each side another piece is placed across the joint and partly indented, notched or tabled into them both, they being further prevented from drawing asunder by keys or wedges inserted as in the last-named joint, and by bolts passing through and connecting all the pieces. Timbers crossing each other are halved at the joint and equally notched or indented one into the other, that they may be incapable of shifting either way. The dove-tail joint is useful when there is a tendency to spread or draw apart, the dove-tail consisting of a broad wedge-shaped projection formed on the end of one piece, and of half its thickness, the broad end outwards, the narrow end stopped by a shoulder on the sides and let into the other piece, tightly fitted into it, the wedge-like form preventing its withdrawal. Various combinations of these joints are used in carpentry,

their application being modified to suit different positions and circumstances.—AUBERY.

QUESTION.—*Give the compressive and tensile resistances of pine and oak.*—The tensile strain per square inch of section to fracture timber by longitudinal tension is about 12,000 lbs. for fir and 15,000 lbs. for oak. The resistance to compression is regulated by the proportion of the length to the breadth of the pillar or strut. Pillars whose length do not exceed twenty times the diameter fail by direct crushing, but above that



proportion the fracture will be partly caused by bending in addition. The following compressive resistances are from various authorities: English oak, 10,000 lbs. per square inch; Dantzic oak, 7,500 lbs.; red pine, 7,000 lbs.; white deal, 7,000 lbs.; red deal, 6,500 lbs.; spruce fir, 6,500 lbs.; pitch pine, 6,500 lbs.; Quebec oak, 5,500 lbs.; yellow pine, 5,350 lbs. The factor of safety for all the above tensile and compressive strains is 10.—T. N.

QUESTION.—*What does the "factor of safety" mean?*—"Factor of safety" is a term used to express the proportion which the safe or working load bears to the breaking or crushing weight. It varies with the different kinds of loads and with the nature of the material employed. The following are the factors used in ordinary construction, given for the experiments of various authorities. For a moving load: Iron, 6; masonry, 8; timber, 10. For a fixed load: Iron, 3; masonry, 5; timber, 4.—T. N.

ADVANCED REPLIES.

QUESTION.—*State the advantages of timber over iron constructions.*—Timber, especially in open roofs, will last, under favorable circumstances, for an indefinite period, extending over hundreds of years, whereas iron is subject to rust or oxidization and the action of various acids, especially in towns, which may be delayed only for a comparatively short period by means of paint or galvanization. A most important point to be considered is that timber will withstand the action of fire much longer than iron. In an ordinary fire a solid beam or pillar of oak will merely become charred for the depth of an inch or two, while the heart will remain firm and strong; but a comparatively slight amount of heat is sufficient to bend and twist, or even melt, wrought iron, with disastrous results, and cast iron when heated, will crack on application of water. It is well known that, on account of these properties in iron, the London firemen would rather enter an ordinary building in case of fire than a so-called fire-proof one. Iron is also very destructive to walls, on account of its expansion and contraction. Buildings constructed entirely of iron, or covered with iron, are very objectionable—besides their ugliness—on account of their extreme heat in summer and cold in winter, iron being a good conductor of heat. A corrugated iron roof will not last more than ten or twelve years.—DRYB.

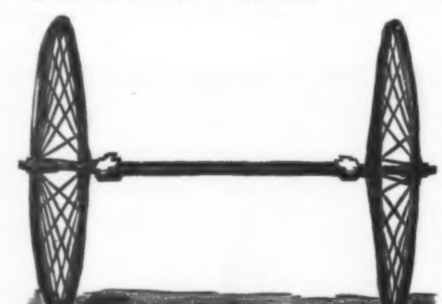
QUESTION.—*Describe the most desirable methods of framing a king-post truss, and give reasons.*—In framing a king-post truss it is desirable that the abutting surfaces should be at right angles, and have an area proportionate to the pressure they have to resist. A simple form of joint for connecting principal rafters is when all the bearing surfaces are exposed to view; they can thus be more accurately fitted, to admit of the pressure being evenly distributed. The abutment should not be less than half the depth of rafter, and perpendicular to the line of pressure. The depth of abutment may be increased with advantage if the junction between rafter and tie is brought over the wall, as in that position the weakening of tie, by cutting, would not affect the strength of truss. An oblique mortise and tenon is also usually formed, about one-fifth the depth of rafter in depth, and about one-third the width in thickness. This prevents any lateral movement of the parts, but is unnecessary if heel-straps or bolts are used. A tenon between foot of king-post and die is also used for the same purpose, and, to avoid weakening the tie-beam by cutting, the depth need never be more than 1½ in., a stirrup-strap being used to suspend the tie to king-post at that point. The mortise in tie-beam should be a little deeper than tenon, so that the shrinkage in depth of tie-beam may not affect the bearing surfaces. The other joints in truss would be regulated by the same rules, care being taken, while fitting them, to allow for shrinkage afterwards. The head and foot of king-post should be of such a width as will admit of abutting surfaces for heads of principal rafters and feet of braces being formed perpendicular to the pressure they transmit, as well as to give sufficient timber to resist the compression to which these parts are exposed. Oak king-posts are sometimes used, the better to withstand this pressure; but a better method is to let the ends of principals and braces (struts) abut against each other, with a piece of sheet lead or plate iron between, so as to equalize the bearing—a pair of suspending pieces being fixed on each side, to secure the ends, and support the tie-beam. The joints between struts and rafters should come immediately under the purlins, so as to take the pressure. All straps used should be of a strength equal to the parts they connect together. King-rods of wrought iron, with heads and shoes of cast iron for ends of rafters and braces, are well adapted for roof trusses. Such rods, as well as heel and stirrup-straps, or bolts, should be so fixed as to admit of the joints being tightened up after shrinkage or sagging has taken place.—S. M. E.

QUESTION.—*A timber partition, 18 ft. long and 12 ft. high, in which there are two doorways, one 3 ft. from the wall, and the other close to it, requires trussing. State the simplest mode of doing it.*—This partition would consist of head, intertie, and sill, with the usual posts, braces, quarters, etc. The partition would be supported, or suspended from the horizontal timbers, the ends of which rest in the walls. A simple mode of trussing is shown in accompanying diagram by a combination of the queen and king-post trusses, the tie for the former being the intertie of partition. The lower ends of braces are framed into intertie near the points of support, the upper ends being framed into the queen-post. The latter is kept apart by a straining-piece. The braces are best when placed at an angle of about 60° from the horizontal timbers. A king-post is framed between the intertie and sill, equidistant from each door, with braces framed between head of king-post and feet of nearest door-posts. A brace is also shown between head of door-post, 3 ft. from wall and the sill—the feet of queen-posts, heads and feet of king-post, and adjoining door-posts to be secured by straps. A wrought-iron suspending rod may be added with advantage through centre of partition, to prevent sagging. The king-post could be omitted, and × bracing inserted between head and feet of door-posts; the quartering being either tenoned or nailed to the horizontal timbers and braces, with stiffeners between, if considered necessary.—S. M. E.—*The Building News.*

THE ARIEL WHEEL.

HAYNES & JEFFERIS, Coventry, Eng., exhibited at the Centennial four Ariel bicycles of an improved character. The peculiarities of the "Ariel" are these: the wheels are made of steel, with rubber tires, and the driving wheel is much larger than the back wheel, which affords greater ease of action and increased speed. Wheels of the same construction are made for carriage builders.

The spokes are made of wire, and the felloe of V shaped steel, covered with solid india-rubber tire. The manufacturers recently prepared a Stanhope phaeton supplied with these wheels, for exhibition at the Royal Agricultural Society, at Taunton, England; and, before the body was rubbed down and painted, the vehicle stood a trial test which proved very satisfactory. Each wheel is hung on a separate revolving axle, rubbing on self-oiling bearings, and it is claimed that this arrangement of separate revolving axles gives it an advantage over ordinary wheels, having a bearing equal to its length, but without the usual amount of friction. If the



axles should spring, however, it would make bad work. The Ariel wheels are formed on the suspension principle, and the felloe is a novelty, being made of V shaped steel, and fitted with a solid india rubber tire. The spokes of the wheels are made of the best Swedish wire, and in case of accident or breakage, may easily and quickly be replaced. As articles of export they are most convenient, for they can be taken to pieces and packed in small cases the size of the wheels. See cut accompanying.

The price in England for the "Ariel" wheels, intended for carriage purposes, is two shillings, or about fifty cents per inch in diameter of the wheel, including axles. The Ariel Bicycles exhibited by this firm are very interesting. An eighty-four inch machine was shown—the largest ever made. Bicycle races occur frequently in England, and very notable records have been made, including 200 miles in one day, 20 miles in one hour, and a single mile in 2:48. The racing machines weigh about 28 lbs., and those for ordinary use 35 lbs. The 200 mile run mentioned above was made on a fifty inch Ariel.—*The Hub.*

COLORS OF ANIMALS.

AT the last meeting of the St. Petersburg Entomologists' Society, October 16, M. Porchinsky reported upon some results on the exploration of a scientific party engaged last summer upon the exploration of the Caucasus. The southern limit of the region explored was the Steppe of Erivan, a plain covered with sand, with some patches of variously colored clays appearing in the low hills. A remarkable feature of the animal inhabitants of the Steppe, insects and reptiles, and especially of the lizards, is the most perfect coincidence of their coloring with the coloring of the Steppe. The same thing was observed also in the Steppe of Elizabethpol. Interesting collections of the fauna made by the party were produced at the meeting.

WOOL DYEING.*

By GEORGE JARMAIN.

COLOR has been well described as the impression which the light, reflected from the surface of a body, makes upon the eye.

Sunlight contains seven colors, which are called the prismatic colors, because they are obtained by the aid of a prism. The surfaces of bodies have the power of reflecting these colors. When all are reflected, the body appears white; when none are reflected, the body appears black; when part are reflected and part are absorbed, the reflected ones give their own impression to the eye; and thus there is produced that infinite variety in combination of color with which we are so well acquainted.

As gaslight and most artificial lights do not contain the whole amount of the prismatic colors which are found in sunlight, those which are not present are not reflected from the surface of bodies, which often appear differently colored by gaslight to what they do by daylight. When a body is seen under the influence of a mono-chromatic light, such as that of sodium, we see these effects greatly exaggerated. As there is only one of the prismatic rays in the sodium flame, namely, the yellow, only the yellow portion of the color of bodies is seen under its influence, the other part appearing black, or very dark.

As the color of a body depends upon the power which its surface possesses of reflecting certain prismatic rays, it is evident that the art of dyeing consists of fixing upon the fabric a substance which will enable its surface to reflect rays different from those reflected by the fibre in its natural condition.

Substances which have the power of changing the reflecting condition of the surface of a body are called coloring matters. Many of these tinctorial agents are derived from the vegetable kingdom, as the dyewoods, some from the animal, as cochineal, whilst others, and a numerous and interesting class, are artificial productions. Each coloring matter has special characteristics of its own, which require a special study, in order that they may be utilized by the dyer to the best advantage. These individual properties and peculiarities will occupy our attention during the succeeding lecture.

* A Lecture before the Society of Arts.

For dyeing purposes, only those colors can be utilized which are soluble in spirit or water, and which have an attraction or affinity for fibre—the color imparted to the fibre having body beauty or permanency, and not being a mere irregular stain. Colors which are insoluble are pigments that can be utilized by the painter and printer, but are of no service to the dyer.

Mr. Bancroft divided colors into two classes: those which possess the power of attaching themselves to the fibre without the aid of a third body he called substantive colors, and those which require the intervention of a third body to enable them to fasten themselves upon the fibre he called adjective colors. This distinction, though not very sharp, is very convenient, and has been generally adopted.

The distinction is not sharp, because colors are frequently adjective to one fibre and substantive to another, and often a substantive color may be very greatly improved by the aid of a third body, when it then virtually becomes an adjective color.

The colors which are substantive to woollen tissue are: The aniline colors, picric acid, indigo, cudbear, and archil. The red and yellow woods partially.

The colors which are adjective to wool are: Logwood, the red and yellow woods, flavine, turmeric, madder, cochineal, and lac dye, etc.

FAST AND LOOSE COLORS.

The dyer must take account of the degree of permanence which his colors will be expected to possess. If the goods, after leaving his hands, have to be scoured in soap and alkaline liquids, and to be milled under the stocks, and then, when worn, to be exposed for a long period to sunlight and atmospheric influences, to sea spray and perspiration, etc., the dyer will fix upon them his fastest colors; but if they be articles of dress which have not even to be washed after leaving his hands, and have to be worn only a few times, and then probably by artificial light, he may venture to put on a loose or fugitive color. These colors are often bright and dazzling in direct proportion to their fugitiveness.

Few colors will withstand unimpaired the direct action of sunlight, the aniline and weed colors, and delicate shades, such as lavender and peach, pinks and greens are often injured and spoiled when exposed to bright sunlight for a few hours.

The action of light upon color seems to be that of a reducing or deoxidizing agent.

Heat, moisture, and perspiration also affect colors injuriously.

The influence of dew upon color has long been known, and before the use of chlorine as a bleaching agent it was customary to bleach linen and calico by exposing the goods for a considerable time on grass, so that they might be submitted to the action of dew by night, and sunlight by day.

The permanency of the color is very much affected by the mode in which the goods are dyed; the duration of the time of boiling, the temperature of the dye-bath, the mordant used, have each their influence on the stability of the dye.

The ordinary coloring matters which may be made fast upon woollen fabric by employing suitable means, are the following:—Indigo, logwood, the red woods, madder, the yellow woods, quercitron bark and flavine, cochineal and lac dye.

The coloring matters which are more or less fugitive when applied to wool are:—The aniline colors, cudbear and archil, picric acid, turmeric, and Persian berries.

As a rule, colors are faster upon wool than upon cotton or silk; indigo is, however, faster upon cotton than upon wool.

Mineral colors do not answer well for wool, Prussian blue being almost the only mineral color employed.

The difference in the tinctorial power of color is very great; thus, one part of flavine will dye a given weight of wool which would require sixteen parts of bark to give the same shade of color, and the depth of color of the solution gives no indication as to its tinctorial power, for a pale yellow solution of picric acid will dye very much more material than an infusion of fustic which may appear quite dark with color.

FIXATION OF COLOR.

Opinions vary as to the mode in which color becomes fixed upon fibre. Some contend that a true chemical combination takes place between the fibre and the coloring matter; others state that it is no true chemical combination, but that the coloring matter is attached to the fibre by a special force in which equivalent proportions do not obtain; others, again, say that the adhesive action is altogether mechanical, and that the coloring matters are absorbed into the pores of the fibre and held there mechanically. Some hold that the color is fixed to the surface only of the fibre by molecular attractions; others think that the fibre is perfectly permeated by the color. There are special reactions which lend force to each of these antagonistic opinions, but for all practical purposes they are not likely to influence the operations of the dyehouse, and they are at the present moment more interesting as theoretical considerations than useful and capable of being turned to practical account in the dyehouse.

MORDANTS.

A mordant is a salt or other substance, by means of which coloring matter can be fixed upon fibre which of itself has no affinity for it. A dyed fabric may, therefore, be considered to be a ternary compound of color, tissue, and mordant.

There are but few colors which have the power of fixing themselves upon fibre permanently without the aid of a mordant; for, as a rule, without such aid, they produce a color or stain which may for the most part be washed out by means of soap and water. And even those substantive colors which can be used without the aid of a mordant, with one notable exception, namely indigo, are rendered both brighter and faster by the use of a mordant.

In the case of indigo, the oxygen of the air, which serves to render the indigo insoluble, and thus to fix it upon the fibre, may be considered as its mordant, were it not that the term has been restricted to bodies which are capable of being applied in solution.

Mordants may be classified in two groups:—

1. Metallic salts.
2. Oils—Albumen and casein.

Metallic salts are the only mordants which are employed in the dyeing of woollen fabrics, and these are mostly confined to the salts or other compounds of tin, aluminium, chromium, copper, and iron.

These compounds fulfil certain essential conditions of a good mordant, which are the following:—The mordant must be soluble, so that it can thoroughly permeate the fibre. If the mordant be already in solution, it must not cause the water to become turbid when it is added to the bath. The

mordant must leave an insoluble deposit within the pores or upon the tissue submitted to its action. The insoluble deposit must be capable of forming a combination with coloring matter, which if it affect it in color at all, it must brighten. The combination should take place slowly, and with regularity.

The salts in common use as mordants for wool, which are found to fulfil the above conditions, are:—Alum and alum cake, bichromate of potash, copperas or protosulphate of iron, blue vitriol or sulphate of copper, and tin solutions.

Most of these salts are of an unstable character, the acid and base being held together by weak affinities; this is notably the case with the iron and tin compounds; alum and sulphate of alumina are more stable, but are decomposed by woollen tissue at a boiling temperature. Bichromate of potash is decomposed in a special manner, which I shall describe further on.

The insoluble matter deposited by the mordant on the fibre is either a subsalt of the metallic base, or a hydrate, or both combined.

The nature of the combination which subsists between the deposited matter and the fibre is involved in the same doubt and uncertainty as those which are encountered in studying the fixation of color. The general opinion seems to be that the insoluble particles of the mordant are retained mechanically within the pores or in contact with the cell walls of the fibre, or that they adhere to the external walls of the cells by some attractive force. Whatever may be the mode, however, by virtue of which they are attached to the fibre, they still retain all their properties of combining with coloring matter and forming insoluble compounds with them.

LAKES.

As the insoluble matter precipitated upon the fibre is frequently a basic salt, the acid of the mordant often exerts a considerable influence upon the colors obtained. A chloride of tin gives a different shade of color with logwood to that produced by a sulphate or sulpho-muriate of tin.

The fact that the colors obtained upon tissues are frequently different in shade, purity, and intensity to the lakes produced with the same mordant and color, seems to give force to the theory that the affinity which holds together the mordant and tissue is of a chemical character.

These insoluble bodies are combinations of the base of mordants with coloring matters; they are obtained when a solution of the mordant is added to a decoction of coloring matter. Frequently the lake does not precipitate until a solution of an alkali is added to withdraw the acid from the mordant salt. It would thus seem that the action of the fibre upon the mordant is somewhat analogous to that of an alkali upon it, in causing a deposit of the mordant hydrate.

MODES OF APPLYING MORDANTS ON WOOL.

In wool dyeing the goods are always mordanted at a boiling temperature.

Boiling seems to have the effect of opening the pores of the wool and expelling the air, thus giving passage to the mordant solution.

The mordant may be either applied before the dyeing operation, along with the coloring matter, or after the dye has been applied. Sometimes it is found advantageous to apply the mordant both before and along with the dye.

The application of too much mordant is to be avoided; this is notably the case with the iron and bichrome mordants, which produce rusty and green shades respectively, when an excess of the mordant has been used.

UTENSILS EMPLOYED IN MORDANTING.

The most convenient vessels for mordanting woollen goods are wood cisterns, 6 to 8 ft. long, 4 to 5 ft. broad, and 3 to 4 ft. deep, with a false bottom made of perforated iron plates. The water is heated by a perforated steam-pipe, 2 in. in diameter, which passes under the plates along the middle of the cistern. When scarlets, oranges, and crimsons have to be dyed with an acid thin mordant, block tin plates should be substituted for the iron plates, which would seriously affect the colors, as iron salts would be formed by the acid acting upon the iron plates. Metallic iron also decomposes tin salts, the tin being precipitated in the metallic state.

$$\underset{\text{Stannous chloride.}}{SnCl_2} + \underset{\text{Iron.}}{Fe} = \underset{\text{Ferrous chloride.}}{FeCl_2} + \underset{\text{Tin.}}{Sn}$$

Large iron pans are also frequently used in both mordanting and dyeing, the water being heated, either by a steam-pipe blowing straight down into the water, or by direct fire-heat under the pan. The steam in this case is only employed to heat up the water to the boil, the subsequent mordanting or dyeing being done by the fire-heat alone. Many experienced dyers prefer direct fire-heat, especially for the dyeing, as a temperature can be obtained which is two or three degrees higher than what can be obtained by steam alone; and fire-heat is more especially preferred for wool, which is kept in a more constant state of agitation by the ebullition of the water than can be obtained by steam heat. The wool is also less liable to be felted or twisted into tails.

A more uniform ebullition and agitation of the liquor may, however, be obtained by passing the steam-pipe, not perforated, several times along the bottom of the cistern, and allowing the condensed steam to discharge itself into the cistern by an upright pipe, bent over above the surface of the liquid. When the steam pressure is not less than 50 lbs. per square inch, this is an excellent and economical mode of heating both the mordant and the dye baths.

When pieces are mordanted or dyed, they are kept in motion by causing them to pass over a wince, placed over the dye vessel and turned by machinery. Three or four pieces are sewed end to end, and are thus passed over the wince continuously.

Wool is kept in motion by being stirred up almost continuously during the process by long poles, called "stangs." The thorough stirring and breaking up at the commencement is of great importance, in order to prevent unequal reception of both mordant and dye.

The mordanting usually occupies from one to two hours, the liquor is then run off from wool, and water run in once or twice to wash out excess of mordant; it is then put in a coach or waggon, covered over with a sheet, and left over night, or longer if convenient. The color obtained after leaving it in this manner is always better than when it is passed direct into the dye-bath after mordanting.

Pieces after mordanting are drawn out of the bath, washed on the washing machine, and left over night before dyeing.

ALUM.

This was the first substance used as a mordant. It is a double sulphate of alumina and ammonia or potash. It was formerly manufactured from certain pyritic shales found on the east coast of Yorkshire, but now it is chiefly obtained by acting on burnt aluminous shales or clay, with sulphuric acid, and afterwards saturating the excess of acid by the addition of ammonia or potash, according as ammonia or potash alum is required. The active mordant agent in alum is alumina, of which potash alum contain 10 per cent., and ammonia alum a little more. The latter is more frequently met with in the market than the former. Ammonia alum may be recognized by stirring up a little of the powdered alum with quick lime or caustic soda, and moistening with water. The smell of ammonia will be given off from ammonia alum. The most objectionable impurity which alum contains is a ferrous salt, which may be detected by the well-known tests for iron, namely, prussiates of potash, or a solution of tannin.

Alum deposits upon wool fibre, with which it is boiled, aluminic hydrate $Al_2(HO)_6$ or subsulphate of alumina, according to the relative proportions of the alum and wool. When the hydrate only is left on the fibre, the sulphuric acid appears to have combined with ammonia formed from some gelatinous principle of the wool which is dissolved during the boiling. M. Havrez, late proprietor of the technical schools at Verviers, made before his death a long investigation into the different reactions which alum gives during the process of mordanting. The general conclusions at which he arrived were, that a weak bath of alum, that is, a bath containing less alum than $\frac{1}{18}$ of the wool, becomes alkaline, and affects color in an alkaline manner. A larger quantity of alum $\frac{1}{18}$ of the wool acts as a weak acid upon colors giving violets upon logwood and the red woods. Large quantities of alum upon cloth act upon colors as alum itself does, giving acid effects, whereas small quantities act as hydrates, giving alkaline effects.

The addition of an acid has the same effect as using an excess of salt, and it is found to be useful in extracting the iron from the fibre which thus becomes purified.

Alum is sometimes employed alone as a mordant, but more frequently conjointly with other mordants. Alone it gives bright colors.

It would be useful to know what is the action of each mordant, when fixed on wool, upon the coloring matters commonly employed in the dyehouse. I am of opinion that these effects are much more instructive to the young dyer than the examination of the precipitates which the mordants give with decoctions of the dyes. I have accordingly mordanted samples of wool with the following mordants:—muriate of tin, alum, sulphate of copper, bichromate of potash, and copperas, and have dyed them with the following coloring matters:—fustic, flavine, American bark, turmeric, sumach, madder, barwood, saunderswood, camwood, and cudbear; and have arranged them in this tabular form, in order that the action of any of the above mordants on the dyes may be readily seen. 50 per cent. of the weight of the wool in color was used with the following dyes:—Fustic, bark, sumac, madder, camwood, barwood, saunderswood, and logwood; 4 per cent. with fustic, 12 per cent. with cudbear. The following quantities of mordants were employed:—2 per cent. bichrome for logwood, 1 per cent. for the other colors; 8 per cent. copperas, with 2 per cent. tartar added; 12 per cent. alum, with 2 per cent. tartar; 8 per cent. blue vitriol, 8 per cent. muriate of tin of 60° Tw. 100 grains of well-scoured and raised white wool was found to be a convenient quantity to operate upon. The mordanting and dyeing were done in an enamelled iron pan, holding about a pint, and heated over a Leoni's gas stove. The wool was boiled with the mordant for an hour, wrung out and left over-night; the dyeing, which also occupied an hour, was done next day.

COPPERAS.

This is another mordant which has been used a long time. It is the crystallized protosulphate of iron, called a ferrous sulphate. It is manufactured chiefly from soft pyrites, which are met with among coals and in the coal shales. The pyrites, when exposed to air and moisture, readily oxidize, and form sulphate of iron and free sulphuric acid; the liquor is boiled with scrap iron and then crystallized.

The most serious impurity to which copperas is subject through mismanagement is alumina. To detect this, the copperas should be dissolved in water, and fully peroxidized with nitrate acid, and then precipitated with excess of pure caustic soda and filtered; the alumina, if present, will be precipitated from the filtrate by the addition of a solution of chloride of ammonium.

The use of copperas has been greatly lessened by the use of bichromate of potash, as a mordant for logwood colors, especially blacks on pieces. Some of the best wool dyed blacks are, however, still done with copperas.

The same explanation of the deposition of the ferrous hydrate upon wool as was given for alum will be sufficient, with this difference, that the ferrous hydrate deposited very quickly becomes partially oxidized into the form of ferric hydrate, by the oxidizing acid of the air; a dyer, however, tells me that he has detected iron in the ferrous condition in the wool, even months after it had been mordanted. This fact seems to prove that there is a true chemical combination between the mordant hydrate and the wool. The reducing action which wool undoubtedly possesses may also assist in restraining the oxidizing action of the air.

Tartar or argol is almost invariably used along with the copperas, in order that the solution may be kept clear, and the too rapid dissociation of the copperas prevented. The tartar, in this and every case where it is used with a mordant for a similar purpose, should be added to the bath first, for it is easier to prevent a precipitation than to redissolve the precipitate after it has formed. Copperas is frequently used simply as a saddener; its effect upon colors is to produce dark shades. It is used both alone and in conjunction with alum and sulphate of copper, but not with bichromate of potash, which it reduces and renders its special properties less effective as a mordant.

SULPHATE OF COPPER,

Called also blue stone, blue vitriol, and Roman vitriol, is not used extensively as a mordant, and never alone. It is used along with alum to obtain logwood blues, and with copperas to produce blue blacks.

BICHROMATE OF POTASH.

This splendid salt is met with in commerce in a state of almost absolute chemical purity. I think it is more extensively used in our woollen dyeing than any other mordant. Its decomposition in the bath in contact with wool is different from that of any other mordant, for its constitution is different. The metal which is deposited as a hydrate upon the wool, is present in this salt as the acid, and not as the base, which is potash. Bichromate of potash may be represented as being neutral yellow chromate of potash, in combination with dry cromic acid, thus:

$$\underset{\text{Bichromate of potash.}}{K_2Cr_2O_7} = \underset{\text{Chromate of potash.}}{K_2CrO_4}, \quad \underset{\text{Chromic acid.}}{CrO_3}$$

To obtain the full effect of the bichromate as a mordant, sulphuric acid is usually employed along with it; the whole or major part of the chromic acid is thus set free:

$$\underset{\text{Bichromate of potash.}}{K_2Cr_2O_7} + \underset{\text{Sulphuric acid.}}{H_2SO_4} + \underset{\text{Water.}}{H_2O}$$
$$= \underset{\text{Sulphate of potash.}}{K_2SO_4} + \underset{\text{Chromic acid.}}{2H_2CrO_4}$$

Chromic acid is a most powerful oxidizer, and acts energetically upon wool, and should, therefore, be used with caution, as we shall see further on. The wool furnishes the reducing agent, probably in the form of hydrogen, which acts upon the chromic; thus:

$$\underset{\text{Chromic acid.}}{2H_2CrO_4} + \underset{\text{Hydrogen.}}{3H_2} = \underset{\text{Water.}}{2H_2O} \times \underset{\text{Chromic hydrate.}}{Cr_2(HO)_6}$$

The chromic hydrate thus produced is deposited upon the wool as the mordant hydrate, a portion of neutral chromate of potash is also usually present on the fibre.

I have ascertained experimentally that it is not safe to use more than three per cent. of the weight of wool of bichromate, for if four per cent. be used the color becomes impaired, and if twelve per cent. be used the wool cannot be dyed with lo. wood at all, and the curious effects of overchroming are produced. These effects are due to the destructive oxidizing action of the chromic acid upon the wool. When a still larger quantity of bichrome is used along with sulphuric acid the wool is dissolved, and a solution of chrome alum is obtained, thus:

$$\underset{\text{Bichromate of potash.}}{K_2Cr_2O_7} + \underset{\text{Sulphuric acid.}}{4H_2SO_4} + \underset{\text{Hydrogen.}}{3H_2} + \underset{\text{Water.}}{18H_2O} =$$
$$\underset{\text{Chromium. Potash.}}{Cr_2(SO_4)_3K_2SO_4} + \underset{\text{Alum.}}{24H_2O}$$

The effects of using various proportions of bichrome upon wool, ranging from two to twenty per cent., were exhibited.

TIN SOLUTIONS.

These are generally called tin spirits. There are great numbers of them in use; every dyer and maker has his own special plan of preparing them, and generally firmly believes that his are the best in existence. I do not think it would be profitable or edifying were I to describe the mode of preparing all there are made; firstly, because I think that at least three-fourths of them are unnecessary, and secondly, because many of them are trade secrets.

The useful and only essential varieties are the following:

The single and double muriates. These are prepared by dissolving granulated tin in commercial hydrochloric acid standing at from 33° to 66° Tw.; diluting with water down to 60° Tw. for the single muriate, and making the double muriate up to 80° or 100° Tw. or more.

The nitrate of tin is made by dissolving tin in single nitric acid of about 33° Tw., and free from nitrous acid. The tin should be added in small portions at a time, to prevent the precipitation of the tin as the insoluble binoxide, metastannic acid.

Scarlet spirits are made by adding oxalic or tartarric acid, or both, to the single muriate.

Blooming spirits are made by adding sulphuric acid to the muriate prepared as above.

The use of tin solution is principally for the purpose of brightening or blooming other colors, and (except in scarlet and crimson dyeing) they are not used alone.

PRACTICAL USE OF FIRE-DAMP.

A SYSTEM of utilizing fire-damp, which promises to be as valuable as it is novel, has just been devised by Mr. R. J. Blewitt, of Norwood, who, by means of a hood, bottomless cage, or air tight chamber, proposes to collect the gas naturally emanating from coal, and by an aperture, with tube and stop-cock, let it out at once into a gasholder, whence it may be conveyed wherever it may be intended to utilize it. In order to render the gas obnoxious in a coal mine, he proposes to extract it by means of a bore-hole and tube on the principle of that used for an artesian well, the tube to be 2 in. in diameter, and extending from the deepest part of the coal intended to be worked to such a height above the surface of the ground as may be possible or desirable. He proposes to obtain and increase the quantity of cyanogen and ammonia by promoting the separation of the nitrogen from oxygen in atmospheric air, and the decomposition of the hydrogen and oxygen in water, and by the decomposition of such elements. Instead of conveying the sulphur usually contained in coal, as iron pyrites or sulphuret of calcium into hydro-sulphuric acid gas, he extracts the former by promoting and awaiting its decomposition and natural re-arrangement in strata; and as to the latter, he converts it by means of chloride of sodium, one of the principal ingredients for producing an artificial lapis lazuli, or ultramarine. As the sulphur separated from the iron pyrites will be in a state of great purity, he disposes of it as a marketable commodity, and the iron or magnetic waste of iron also. As to all the products arising from the distillation of coal, he produces them in the usual manner, but with far less expense, and without any of the offensive odors which accompany the present system.—*Ryland's Circular.*

IRON IN DIAMONDS.

DR. COHEN, of Heidelberg, has examined the "specks" which are to be found in many of the crystals of diamonds from the Cape. He thought at first that they were particles of another modification of carbon. In a large diamond, weighing eighty carats, however, he discovered a crystal of specular iron, the larger faces of which lie parallel to the octahedral face of the diamond. Lustre, color, and form (rhombohedral), all combine to identify it with specular iron, and the crystal in its habit closely resembles those occurring at St. Gothard.

MARINE MOSSES.

M. GISARD lately showed to an audience at the Congress of learned societies at the Sorbonne, specimens of marine mosses growing on a madrepore placed in an aquarium, since January, 1872. They produce every year, in spring, phenomena of fructification, consisting of urns of a superb nacreous color, growing at the ends of beautiful green filaments, then becoming detached and rising to the surface of the water. He cited the following fact as showing the vitality of certain marine plants. On May 13, 1875, a parcel of algæ which had been taken from an aquarium and dried several months in the sun, was placed in sea water, and developed a magnificent green plant of ribbon form. In February and March, 1876, there were formed on the border of the ribbon sparse filaments carrying rounded urns of variegated color, which became detached, and rose to the surface, giving rise to green plants.

EXTRAORDINARY HAIL-STONES.

WE extract from *La Nature* the annexed engravings of some remarkable hail-stones which fell during a severe storm over Paris, France, in September, last. Nos. 1 and 5, Fig. 1, are sections of the most common stones. In No. 1 the interior is opaline white without concentric layers. In No. 5, on the contrary, the concentric layers are clearly indicated. The center one and the spaces between the strata alone are opaque. The shape indicated by No. 2 has two horn-like

FIG. 1.

projections between which are numerous gas bubbles. Some of the stones appeared to be double, but the horns being broken by the descent, they were not examined. Nos. 3 and 7 have globular projections, like the surface of a raspberry, the others, 4 and 8, are remarkable for the presence of very large gas bubbles.

Another remarkable series of stones which likewise fell in France some time ago is represented in Fig. 2. No. 1 is surrounded by points, and has an opaque central nucleus, which

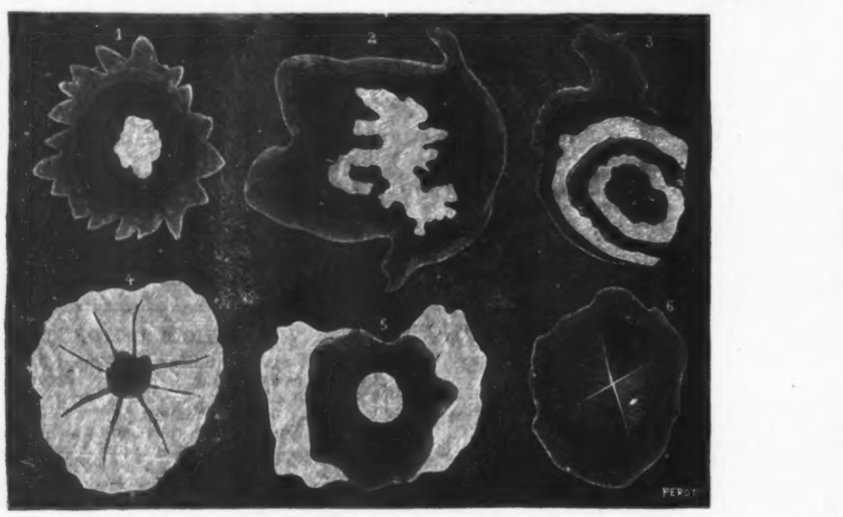


FIG. 2.

in No. 2 assumes a very irregular form. No. 3 is made up of alternate opaque and clear strata. In No. 4 the nucleus is transparent, and needles shoot from it in all directions. No. 5 is opaque in the interior and at the center, and No. 6 is remarkable for its internal marking, denoting a crystalline structure.

AN AMERICAN ASTRONOMICAL ACHIEVEMENT.

By RICHARD A. PROCTOR.

AN American astronomer, Professor Young, of Dartmouth College, Hanover, N. H., has recently achieved a victory over a problem which has for many years foiled the skill of the best European observers, and, in so doing, he may be said to have added the keystone to an arch of no small importance in the edifice of modern astronomical science. It will be in the knowledge of most of my readers that astronomers have succeeded, during the last eight years, in measuring the rate at which some of the stars travel from or towards us, employing for the purpose what is called the spectroscopic method. I do not mean here spectroscopic analysis simply, but a special application of this now familiar analysis to measure the rate at which luminous bodies are approaching us or receding from us. The principle of the method is very readily explained. Light comes to us from the heavenly bodies, as from other luminous bodies, in waves, which sweep through the æther of space at the rate of about 185,000 miles per second. The whole of that region over which astronomers have extended their survey, and doubtless a region many millions of millions of times more extended, may be compared to a wave-tost sea, only that instead of a wave-tost surface there is wave-tost space. At every point, through every point, along every line, athwart every line, myriads of light waves are at all times rushing with the inconceivable velocity just mentioned. It is from such waves that we have learned all we know about the universe outside our own earth. They bring to our shores news from other worlds, though the news is not always easy to decipher.

All the celestial bodies are in motion amid the multitudinous waves of space. Something can be learned respecting their motions by studying their waves. If a strong swimmer were stemming a series of long rolling waves, their crests would pass him in more rapid succession than if he were at rest; if on the other hand, he reversed his course, so that waves overtook instead of meeting him, their crests would pass in slower succession. One can easily conceive how, if he knew the exact rate at which the crests would pass him—so many, exactly, per minute—were he at rest, their slower or more rapid succession might indicate how fast he himself was moving, either from or towards them. If he were quite unconscious of his own motion, the effect would be simply that the distance from crest to crest would seem to be diminished in one case, lengthened in the other—that is, the waves narrowed or widened. Similarly with the aerial waves which produce sound. They are seemingly shortened when the source of sound is approaching, whether by its own motion or the hearer's, and lengthened when the source of sound is receding. In the former case the tone of the sound is made more acute, in the latter graver than it really is. This is strikingly illustrated when a swift train rushes past a station, the whistle sounding all the time, for there is a perceptible lowering of the whistle's note as the engine passes a hearer on the platform. While the train is approaching him, he hears a note somewhat sharper than the true note of the whistle; after it has passed he hears a note somewhat flatter than the true note. Still more obvious, even to non-musical ears, is the corresponding change when two trains pass each other. In America, where a hideously clanging engine-bell is used, the change is very remarkable, insomuch that a person unfamiliar with the arrangement actually adopted would suppose a different bell was rung the moment the engine passed the hearer.

Light travelling also in waves, it is obvious that a similar effect must be produced by approach or recession, if only the rate of motion is sufficiently rapid. The swimmer of my first illustration must have a velocity comparable with that of the water waves, or no change will be observed. The trains of the second illustration must have a velocity comparable with that of the aerial waves producing sound, or no change of tone will be produced. And in like manner, a star or other celestial body must be approaching us, or receding from us, with a velocity comparable with that of the ætheral waves producing light, or no change of color will be produced, the color of light corresponding with the tone of sound. Unfortunately for this purpose, though most fortunately in other respects, light travels at so enormous a rate that even the swiftest motions of the heavenly bodies seem rest by comparison. What, for instance, is the rush of Newton's comet past its point of nearest approach to the sun, though at a rate of more than three hundred miles per second, to the flight of light over nearly two hundred thousand miles in the same time? Very much as the movement of a person taking only six steps a minute, each less than half a yard long, to the rush of the swiftest express train. Yet astronomers have undertaken to measure the approach and recession of stars, moving, in some cases, with less than a tenth part of that comet's motion, and whose velocity, therefore, sinks into still more utter insignificance by comparison with that of light.

Secchi claims (but not justly) to have first invented and applied the method used for this purpose, which consists in noting whether some known line of the spectrum of a heavenly body changes in position—either by moving towards the violet end of the spectrum, which would imply approach, or by moving towards the red end, which would imply recession. Of course the method is exceedingly delicate and difficult, involving a number of details which would be quite unsuited to these pages; but that, in principle, is its nature. Secchi tried the method, and failed to get any results from it, announcing his unsuccessful attempt in March, 1868. "Then," he says, "Mr. Huggins retired (*reprit*) the method, announcing in April, 1868, the discovery that Sirius is receding at the rate of 20 miles per second." Secchi should know well, however, that our great spectroscopist did not achieve this success in the few weeks between Secchi's announcement of failure and Huggins' announcement of success. Months had elapsed, during which Huggins had been struggling with this difficult problem. If the enunciation of the method gave claim to the credit of its successful application, I myself could advance a stronger claim than Secchi's, for in an essay in *Fraser's Magazine* for January, 1868, I definitely indicated the nature and value of the method. But I would rather refer to the circumstance as enabling me to support Huggins' assertion that he was observing by this method for months before Secchi announced his own failure, for immediately on the appearance of my essay I received a letter from Dr. Huggins, mentioning (in confidence, until his paper should be published) that he had been for some time striving for success by the method I had described. This was nearly three months before Secchi's paper appeared. Subsequently Huggins observed by this method a number of stars, some of which he found to be receding from us, others approaching us.

Recently, however, the method itself has been called in question—first, by Van der Willigen, for reasons professedly mathematical, but unsound; secondly, by Secchi, because of his failure to see what Huggins has observed. Secchi had once based his attack on his failure to detect by this method the effects of the sun's rotation. As the sun's equator is spinning swiftly round, it is necessarily approaching on one side and receding on the other. By some amazing miscalculation, never yet explained, Secchi made the rate of this motion many times larger than it really is—so large, in fact, that the method we have described should have exhibited the sun's whirling motion. Small as the effect really is—amounting, in fact, only to a relative motion of about two and a half miles per second, Huggins did not despair of recognizing it; but he failed, though he used a double and twice-acting battery of prisms (the invention of the present writer—so far at least, as its duplex character was concerned) made by Mr. Browning. Mr. Christie, of Greenwich, after resolutely grappling with the work of determining star motions by this method, and in the main confirming Huggins' results, succeeded in recognizing by its means the known motions of Venus towards or from the earth, in various parts of their respective orbits. This was a great triumph, and more than met Secchi's objections. But Professor Young has gone, for the present, ahead of all other observers by this method. Availing himself of a beautiful extension of spectroscopic powers, due to Dr. Rutherfurd, of New York, he has succeeded in unmistakably recognizing the effects of the sun's motion of rotation by the spectroscopic method. Young has made the observations so satisfactorily, that he relies even upon the difference between his results and the measured rate of the sun's rotation. He finds the sun's atmosphere (whence, of course, the spectral lines come) to be travelling faster than the sun's visible surface. To use his own words: "The solar atmosphere really sweeps forward over the underlying surface, in the same way that the equatorial regions outstrip the other parts of the sun's surface." The difference of rate is about ten miles per minute. For my own part, I doubt very much whether so small a difference can be indicated by this method. But even if we regard this part of Young's work as not yet proven—nay, even if we go further, and accept nothing more than the bare recognition of the sun's rotation by the new method—he must be congratulated on having effected the most delicate piece of spectroscopic observation yet achieved by man. He has placed beyond doubt or cavil a method of motion-measuring the most remarkable yet invented, and likely, as instrumental means improve, to be most fruitful in results of astronomical interest and importance.—*English Mechanic.*

THE DISTANCES OF THE STARS.

WE shall here endeavor to present at one view the most reliable results of investigations relating to stellar parallaxes up to the present time. In making the selection parallaxes less than a tenth of a second of arc are omitted, except in the case of the pole-star, for which independent researches have given values closely approximating to this amount. In estimating the "light-years," we adopt Struve's determination of the time occupied by light in traversing the mean distance of the earth from the sun, viz., 8m. 17·78s. (According to Leverrier's last value for the solar parallax, and Clarke's diameter of the earth's equator, this would assign for the velocity of light, 185,360 miles per second, at which rate of travelling it would arrive at the planet Neptune in 4h. 10m., or the breadth of the planetary spaces as at present known would be traversed in less than 8½ hours.) By "light-years" is of course to be understood the interval which light would require to pass from the star to the earth at the distances respectively assigned.

The authorities are, for α Centauri, Henderson's value as corrected by Peters, and that of Moesta, the mean; for 61 Cygni, Auwer's mean of his own result and that of Otto Struve; Lalande 21185, Winnecke; β Centauri, Sir Thomas Maclear; μ Cassiopeæ, Otto Struve; Groombridge 34, Auwers; Capella, Otto Struve; Lalande 21,258, Krüger; Oeltzen 17415, Krüger; σ Draconis, Brünnow; Sirius, Gylden from Maclear's observations at the Cape of Good Hope; α Lyræ, Brünnow's mean; 70 Ophiuchi, Krüger; η Cassiopeæ, Otto Struve; Procyon, Auwers; Groombridge 1830, a mean of results of Brünnow, Schlüter, Wichmann, and Otto Struve; and for Polaris, Peters.

Name of Star and Magnitude.	Annual Parallax.	Distance in Solar Distances.	Light-years.
α Centauri (1 and 4)	0″·928	222,300	3·5
61 Cygni (5½ and 6)	0·553	373,300	5·9
Lalande 21185 (7½)	0·501	411,700	6·5
β Centauri (1)	0·470	439,100	6·9
μ Cassiopeæ (5½)	0·342	603,100	9·5
Groombridge 34 (8½)	0·307	671,900	10·6
Capella (1)	0·305	376,300	10·7
Lalande 21258 (8½)	0·271	761,400	12·0
Oeltzen 17415 (8½)	0·247	835,100	13·2
σ Draconis (5)	0·246	838,500	13·2
Sirius (1)	0·193	1,069,000	16·9
α Lyræ (1)	0·180	1,146,000	18·0
70 Ophiuchi (4½)	0·162	1,273,000	20·1
η Cassiopeæ (4½ and 7)	0·154	1,339,000	21·1
Procyon (1)	0·123	1,677,000	26·5
Groombridge 1830 (6½)	0·118	1,748,000	27·6
Polaris (2)	0·091	2,267,000	35·7

In the third column is given the distance of the star from the earth, in mean distances of the earth from the sun, as is usual; it will be seen how greatly the alteration, even of a single unit in the last decimal place of the annual parallax in the preceding column, affects these numbers.

So far as our present knowledge extends, light, travelling at upwards of 185,000 miles per second, requires 3½ years to pass from the nearest fixed stars to the earth, and it does not reach us from our well-known northern polar star in less than 35 years.—*Nature.*